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Vol. II
TRANSCRIPT OF RECORD
(Pages 273 to 586)

Supreme Court of the United States

OCTOBER TERM, 1945

No. ~~290~~ 24

HALLIBURTON OIL WELL CEMENTING COMPANY,
PETITIONER,

vs.

CRANFORD P. WALKER AND CRANFORD P. WALKER, D. A. WALKER, ET AL., DOING BUSINESS AS DEPTHOGRAPH COMPANY, COPARTNERSHIP

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE NINTH CIRCUIT

PETITION FOR CERTIORARI FILED AUGUST 2, 1945.

CERTIORARI GRANTED OCTOBER 15, 1945.

No. 10513

United States
Circuit Court of Appeals
For the Ninth Circuit.

HALLIBURTON OIL WELL CEMENTING COMPANY, a Delaware corporation,

Appellant,

vs.

CRANFORD P. WALKER and CRANFORD P. WALKER, D. A. WALKER, ROBERT P. MILLER and MILO C. KETCHUM, doing business as Depthograph Company, a copartnership,

Appellees.

CRANFORD P. WALKER and CRANFORD P. WALKER, D. A. WALKER, ROBERT P. MILLER and MILO C. KETCHUM, doing business as Depthograph Company, a copartnership,

Appellants,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY, a Delaware corporation,

Appellee.

Transcript of Record

In Five Volumes
VOLUME II
Pages 273 to 586

Upon Appeals from the District Court of the United States for the Southern District of California, Central Division

Rotary Colorprint, 590 Folsom St., San Francisco

RANDOLPH W. CORNES

a witness called by and on behalf of the defendant, testified as follows:

My address is 305½ North Twelfth Street, Duncan, Oklahoma. I am an engineer with Halliburton Oil Well Cementing Company. I am in charge of the Echo-Meter operations of the Halliburton Oil Well Cementing Company. I have available here in the court room an Echo-Meter apparatus as built and used by the Halliburton Oil Well Cementing Company.

The Court: What is the rubber hose?

A. That rubber hose is just used as a substitute for the oil well. This equipment here is the unit which is attached onto the well normally, and the hose takes the place of the well. This branch of the unit comprises the gun which initiates the sound which goes down the well.

The Court: Does that go down the well, or go into the chamber adjacent the well?

A. This part of the apparatus is connected directly into the top of the well, and the sound comes from the gun, and goes into the well, down through the annular space into the well.

The Court: It does not appear to be that way from the diagram, according to the answers to the interrogatories it was attached to 8; then, under the supplement to the answers, there was a valve at 8, which is 8-A, so it is attached to a valve or pipe which is attached to the well.

A. The unit is attached into the valve, into the

(Testimony of Randolph W. Cornes.)

well. [280] The valve is not necessarily a part of the equipment.

The Court: There is either a valve or an elbow there?

A. Yes, or it can be connected straight into the well. There is a pipe fitting there with which you can screw it into the casing, and the equipment which we attach is attached to that pipe fitting. The shot is fired into that unit. The shot travels through the pipe fitting, through the L down into the well, and down that annular space I described.

The Court: So the shot is really fired into a chamber which appears to be a V-shape or elbow?

A. That elbow is slightly different from this branch, which comes this way. The other is off at an angle.

The Court: Is that put into the top of the casing, the elbow, in a V shape, like that, or is one of those vertical, like you have in the drawing?

A. That unit is attached which comes off the V-shape.

The Court: You have different types of unit?

A. There is no essential difference there. That was made for convenience to lighten the unit. The shot is loaded into this electrically fired gun, and it is fired by releasing the mechanism in the gun. As the shot is fired it goes down through this pipe fitting, and on into the well, and the reflections that come back from the well come through the pipe fitting unit, back through the opposite branch of this Y, through the adjustable valve and into the

(Testimony of Randolph W. Cornes.)

microphone, which is in the pipe fitting [281] or union of that branch of the Y.

By Mr. Babcock: What is the red chamber with a valve above the union which you said contained the microphone?

A. That is what is called the surge chamber, for the sound.

The Court: From here, the place where you fired the shot has a handle out to the side?

A. Yes. The handle is merely for removing that gun, to allow the operator to get a good hold on the gun when he puts the shot in here. This is the firing mechanism, such as the breech on a gun.

Mr. Babcock: Q. What is the purpose of having this coil of rubber hose attached to the bottom of the unit?

A. That is merely to simulate an oil well in demonstrating the equipment. It is approximately 100 feet long.

The Court: What is that open valve for on the right arm in the surge chamber?

A. That is for attaching a pressure gauge in case there is pressure in the well, and you want to read the pressure. That valve is closed now.

Mr. Babcock: Q. Now please explain the apparatus in the wooden box, which you have here in the courtroom.

A. This apparatus consists of an electrical amplifier which is connected through a cable to the microphone in the casinghead unit. The signal from the microphone comes into the amplifier,

(Testimony of Randolph W. Cornes.)

and is applied with sufficient intensity to run this [282] recorder in the back part of the box. The electrical signals from the amplifier cause this cylinder here, the cylinder which the paper travels across, to move back and forth, and as the paper is driven across the cylinder by the motor driving the recorder, and is driven electrically from the amplifier back and forth, the record is traced on that tape in that manner.

The Court: The thing that jiggles is not the pen; it is the paper?

A. The pen is stationary. The paper moves back and forth crosswise with the signal. The constant speed from the motor drives the paper lengthwise.

Mr. Babcock: Q. Will you name the electrical elements involved in this apparatus in the box in transmitting the signal from the microphone to the recorder,—I mean what elements are necessary to cause that recorder to make a record on the tape in response to signals from the microphone.

A. In the first place, there is a battery in here, used to energize and pass current through the microphone. That current heats the microphone, and the signal which comes back from the well cools that microphone wire; that is, each signal cools the wire slightly as it passes the microphone. That cooling of the wire changes the wire's resistance, which changes the current flow through that circuit, and introduces the signal into the amplifier.

(Testimony of Randolph W. Cornes.)

The amplifier is made up of radio tubes [283] similar to an ordinary amplifying system. The signal goes through that amplifier, and comes out with sufficient intensity to have energy enough to move this cylinder here. There is an electrical filter in there, operated by this center control. In the position it is in now, the filter is turned off; disconnected entirely from the circuit.

In the Echo-Meter operations of the Halliburton Oil Well Cementing Company the filter is not always used. This is the same apparatus that we had out in the field the other day at Dominguez, when you invited counsel and Mr. Walker and some of the others for the plaintiffs to witness defendant's operations.

Q. Will you please demonstrate to the court, how this device operates to make a record of the firing of the shot, and of an echo therefrom?

As you manipulate the apparatus in any way, state what you are doing.

A. I first load the gun with a small 22 blank shell, which is of sufficient size for this demonstration. The gun is loaded; then cocked by pulling back this small handle. I just cocked the gun. This is an electrically fired gun.

The Court: Is that gas in that hose?

A. Just air. It operates the same as air or gas in an oil well; it will make no difference. [284]

Mr. Babcock: Q. Is the butterfly valve beneath the microphone open or closed?

(Testimony of Randolph W. Cornes.)

A. It is slightly open. It makes very little difference for the purpose of the demonstration how it is. There is a sufficient opening there. When the gun is loaded, this switch is turned on on the amplifier here. First, just in a position which heats up the tube; then in the second position, the current passing through the battery into the microphone, in the third position, turns on the amplifier. The final position starts the tape going, and pressing this button fires the gun.

Q. Is the gun now fired?

A. The gun is fired. When it clicked, at the time I pushed the button, it was fired, and gave us this tape.

Mr. Babcock: I offer in evidence this tape as Defendant's Exhibit C, this being a tape made with the apparatus demonstrated in court.

[Printer's Note: Defendant's Exhibit C is set out in full in the Book of Exhibits.]

The Court: That hose is closed on one end, is it? A. Yes, it is, your Honor.

Mr. Babcock: There appear to be a number of deflections or wiggles in the line drawn on the tape. Explain what those are.

The Court: Which is the bottom, and which is the top of the tape? Where is the shot fired? Indicate that.

A. I will mark it on the tape. This first line of reflection is where the shot went off. [285]

The Court: Which way does the tape travel? Indicate that by an arrow.

(Testimony of Randolph W. Cornes.)

A. The tape is traveling in the machine so that this large reflection is the first one to pass through. This smaller movement of the pen here is the first reflection of the sound coming in the hose. I will mark this point "first reflection".

The Court: At the end of the hose?

A. I will mark it "end of the hose". The sound is then traveling from the gun to the end of the hose, and back to the microphone, where it is recorded here. Then a similar reflection——

The Court: That has traveled 200 feet, the sound?

A. Yes, it has; then the small reflection back. The sound traveled through the hose and back to the microphone at the end, which would give this end of hose reflection here.

The Court: That is the end again?

A. The end again.

The Court: How many times did it go through there before it stopped?

A. Because of the small size of the hose it dimmed out quite rapidly, and only the two reflections show up.

Mr. Babcock: Q. In between the deflection indicating when the shot was fired and that which indicates when the echo returned from the end of the hose are there any waves?

A. There is a small wave there indicating a coupling in the hose about half way through the length of the hose. I will [286] mark that on the chart as the coupling echo.

(Testimony of Randolph W. Cornes.)

Q. In this apparatus which you have just demonstrated, did you use the filter when making that chart? A. No, I did not.

Q. It was not in the circuit at all?

A. No.

The Court: Between the end of the hose, the first end of the hose, and the end of the hose No. 2, there are a lot of jiggles. What are they? They all seem to be about regular.

A. I don't think there is anything particularly that they could be attributed to. There is no definite reflection point in there.

On September 29, 1942, I demonstrated this apparatus on an oil well at Dominguez, California, for Mr. Walker and counsel for plaintiff.

This apparatus here in court, except for the hose, is one of the commercial apparatuses used by the defendant.

Mr. Babcock: I offer this print at Defendant's Exhibit D.

[Printer's Note: Defendant's Exhibit D is set out in full in the Book of Exhibits.]

The Court: Those are prints of well graphs, are they?

Mr. Babcock: Made to demonstrate defendant's apparatus to the plaintiff, on the Union Oil Company Well Callender No. 79, Dominguez field, on September 29, 1942.

Q. This chart Exhibit D appears to have six graphs. Will [287] you please explain what each of those is?

(Testimony of Randolph W. Cornes.)

A. I will start at the right hand side. Chart No. 1 is a record made on this well using the regular equipment which we use on a commercial operation, using a ten-gauge blank shell as the source of sound, and no filter. No. 2 is made in the same manner, except that the filter was used to get that record. Record No. 3 is the same as record No. 1, that is, with no filter; but with a .38 blank cartridge instead of a ten-gauge which was used in No. 1. No. 4 is the same as No. 3, that is, a .38 blank, but the filter was used. It is marked "filter set at 3.7" which is the same setting which was used on record No. 2.

The Court: What does that mean on that graph No. 4, "Valve closed"?

A. The small valve, butterfly valve near the microphone was closed when that shot was made, and it was also closed when the two pervious shots were made. with a filter and without, on charts 2 and 3. On chart No. 5, the .38 blank was used and the filter was used, but the filter was set at 6.0 rather than being set at 3.7. Then on record No. 6—well, let's go right back to record No. 5. The amplification setting on the amplifier was set at 20 and increased to 35 near the end of the record. Then record No. 6 is of the same type, except the amplification was a little higher, starting at 22 and going as high as 46, both using the filter set at 6.0. [288]

Q. Let us go back. In chart No. 2 where was the filter set? A. Set at 3.7.

(Testimony of Randolph W. Cornes.)

Q. And why was it set at that point?

A. Record No. 1 was taken first, with no filter, and then ten collars—you can see the ten collars marked off about 6 inches from the top of the record of chart 1. There is two marks on it. The length between those two marks, the length of those ten collar reflections was measured with a scale and found to be 3.7 centimeters. Then the filter knob on the instrument was turned to 3.7 to correspond to that reading, which turns the filter on, connected with the end of the circuit and automatically set it at the right value.

The Court: You measured the distance between ten tubing collars on chart No. 1?

A. That is right.

Q. The distance between the first one to the end.

A. Yes, the distance between the two marks.

Q. What relation has that with the amount of electrical energy in the filter?

A. That adjusted the filter to the proper setting or frequency with which these echoes came back. The filter is calibrated in that manner to save referring to our frequency and using a calibration chart of some kind.

Q. That is, the ratio begins with 10, is that it, so you counted 10 of these and this was 3.7? [289]

A. That is right.

Q. And whatever distance it takes to count 10 echoes, why, that is where you set your filter?

(Testimony of Randolph W. Cornes.)

A. That is right, your Honor. It could be adjusted for some other value, but 10 is a convenient count-off, so that is always used.

Mr. Babcock: Q. So that in setting the filter to make run on chart 2, you set the filter in such position as to be particularly responsive to the length of tape between the ten tubing collar reflections on tape No. 1?

A. Yes.

Q. Now, in charts 5 and 6, what was the purpose in setting the filter off at some other value?

A. That was done to see whether it would affect the appearance of the record any if the filter was set at the improper value.

Q. Settings on charts 5 and 6 were for improper values, according to the data obtained on chart 1?

A. Yes, almost double what it should have been.

The Court: Well, wouldn't there have been a difference on a .38 shell from what there was on a ten-gauge?

A. No, your Honor. The spacing of the collars there is the same regardless of the source of the sound used. The sound would travel through the gas at the same speed regardless of the amount of energy. [290]

Mr. Babcock: Q. What relation does the amplification bear to the kind of shell used in making the sound?

A. With the smaller shell it usually takes more amplification to get the same type of record.

(Testimony of Randolph W. Cornes.)

The Court: Of the 10 there, isn't that right in the middle? Wouldn't five of those be just before the fluid level and five of them back?

A. No. The fluid level, your Honor, is about two inches farther down on the record, that larger reflection there.

Q. There is the fluid level, but the sound don't record on this until it hits the top of the casing, does it, until it hits the microphone?

A. After the shot has been fired the sound starts down the well and a small fraction of it is reflected from the first collar. That small fraction comes back up to the surface and gives this first kick. Then the sound travels on down to the second joint and comes back up to the surface to give the second kick, and so on down until it hits the fluid level and comes back up to the surface and is recorded in that large kick, large reflection.

Q. The number of these jiggles, then, is the number of collars from the top of the fluid level?

A. That is right.

Q. And is not twice the number of collars?

A. No; because the sound has passed each one and a small [291] part reflects it back up, so the small jiggle just ahead of the fluid reflection is the collar just above the fluid surface.

Q. Why is it bigger?

A. Why is the fluid reflection larger?

Q. No; the collar above the fluid reflection on that No. 1 column there. It is bigger and the next

(Testimony of Randolph W. Cornes.)

one is smaller. It does not follow the straight line, but a little ways here, and it is eccentric.

A. That is due probably partially to noise and disturbances in the well, and partially to the operator's control of the amplitude, that is, the amplitude is increased throughout the record and it may not be increased at a uniform rate. In other words, it may have been increased a little bit more in relation to the amount of sound arriving in some case and giving a larger reflection, and others giving a smaller.

Q. Well, that way, then, the operator here might turn the juice on and get an amplification of a collar which would indicate a large jerk in the line?

A. That is right.

Q. Which otherwise would be taken to mean some material which would reflect an echo, such as a tubing catcher or artificial element placed in there to reflect sound, is that correct?

A. It is. It takes a little experience to manipulate that control properly so you would get it.

Q. So this is not automatic; you don't set this in the [292] beginning and let it do it itself?

A. That is right.

Mr. Babcock: Q. In chart 1 and chart 2 of this exhibit D, graphs 1 and 2, tubing collar reflections do appear, do they not? A. That is right.

Q. The same is true of all the other graphs of this exhibit? A. Yes.

Q. To bring out the relation between when a

(Testimony of Randolph W. Cornes.)

filter is used and when a filter is not, would you compare graphs 3 and 4, for example?

A. There is a slight difference between 3 and 4. For instance, about three-quarters of the way down the record, the collars where the filter is used appear to be somewhat more uniform there. That is the essential difference there. Chart No. 3 has slightly more amplification than No. 4, but that is not a function of the filter.

Q. Can the tubing collars be counted in each case? A. They can.

Q. Can they even be counted with the filter set in the wrong position as in charts 5 and 6?

A. Most of them can. There are several places there which might be difficult to count accurately, but a large number of them could be counted.

The Court: How far down is it?

A. Do you have one of those records which is counted? [293] Well, I will count one of these. We will start out with No. 1, which has a fraction over 65 joints, tubing collar joints, above the fluid, if I counted correctly there.

The Court: Well, how deep is it?

A. I don't know the exact length of the tubing, but assuming the tubing is 30 feet, which would be pretty close, it would be 1,956 feet from the surface of the fluid, that is, 30 times 65.2, that would be 1,956.

Mr. Babcock: If the court please, I would like the witness to mark on that exhibit the fluid levels on each of the graphs—fluid level reflections on

(Testimony of Randolph W. Cornes.)

each of them. The witness has written "Fluid reflection" on each of the graphs on Exhibit D.

The Court: These irregularities such as in column No. 4 below where you have marked one fluid reflection, about 30 spaces down, is that due to a greater impulse of electricity in turning the knob higher, or is that due to some resonance in the well? Take on No. 6 over here, it is very irregular.

A. That is partially due to turning the amplitude control probably, and also due to the filter setting being so much in error.

Q. It is partially due probably?

A. Well, it is a combination of those factors, and, perhaps, some others coming in there.

Q. Then it isn't anything in the well that causes an echo to be greater and make those marks?

A. Well, there are cases in wells where you may get [294] stronger reflections from one depth than from another, that is, stronger reflection from a deeper section than you will a shallower.

Q. This is a recurrence of the record at the top in No. 4. That is pretty regular all the way through to the fluid reflection, and then below the fluid reflection it gets very small and very large, and very small and large, and then practically disappears into a straight line up about half an inch, and then up again, indicates some irregularities.

A. I believe that is principally due to the manipulation of the control.

The Court: I see.

(Testimony of Randolph W. Cornes.)

Mr. Babcock: Q. What size cartridge or shots does the defendant use commercially in its gun?

A. 10-gauge shells and .38 shells; 10-gauge blanks and .38 caliber blanks.

Q. Would one of them be satisfactory for all wells?

A. The 10-gauge shell should be satisfactory in all cases.

Q. Why do you sometimes use the .38?

A. Principally because it is less expensive.

Q. Do you have a hot-wire microphone here?

A. I have one in my pocket. Here is one here.

Mr. Babcock: Let us give that an exhibit number. I offer into evidence the hot-wire microphone produced by the witness as Defendant's Exhibit E.

[295]

The Court: The wires are not hot all the time, are they?

A. No; not unless they are in the instrument, and then they don't get very hot.

Q. They have to be activated by electricity, don't they?

A. Yes, they do. They are heated electrically the same as a lamp or flatiron. The device consists simply of a disc with a grid. The disc fits in the coupling in the casinghead unit. That is the small tungsten wire wound across there on both sides. It starts on one side, goes back and forth, then across on the other side. That small wire is the wire which is heated by the electric current,

(Testimony of Randolph W. Cornes.)

and being so small, a very small sound or impulse of gas will cool that wire off, because the electrical characteristics of it change and gives a signal.

Q. How is it heated? Through these same wires there?

A. Yes. And on either side what you are looking at is a little terminal box and those are connected electrically to terminals inside of the pipe.

Q. Are these connected through these little screws?

A. The wire is connected through one end to one side, and the other end to the other side. The end of the wire is under the little screw. The end of the wire comes under the screw and the screw tightens down on it, and the connection is made by —the disc slips over a couple of rods there. The rods slip through those small round holes there, and is held in [296] place by two small knobs so it will make contact.

Q. Does this reproduce sound?

A. It picks up sound which moves through or causes changes in the heat in the wires. The sound represents the movement of the gas, movement of air or gas, and that movement of the gas cools the microphone—cools the wires, and that cooling is what causes the change in electrical characteristics of the wire. The electrical variations caused by that microphone are amplified.

I was educated at the University of California at Los Angeles and the University of California,

(Testimony of Randolph W. Cornes.)

majoring in physics. I have a degree of A.B. granted by the University of California.

I am familiar with the patent to Paul E. Lehr and Harold J. Wyatt No. 2,047,974, granted July 21, 1936 on an application filed November 1, 1933. I have built an apparatus in accordance with the disclosure of Figure 2 of that patent. Figure 2 of that patent shows an impulse chamber. That is reference No. 4. Also with a supply of gas No. 1 connected to that impulse chamber by this pipe No. 2. There is a pressure gauge on the impulse chamber No. 5, that is connected into the casing of the well No. 14. The well contains tubing also, No. 8, and on the opposite side of the well is connected to a small fitting No. 13, the microphone No. 15. That microphone is connected to an amplifier No. 18, and then by wires No. 17 to a recording mechanism, apparently a pen recorder. This stylus is No. 22. [297]

Mr. Babcock: Q. How did you build the apparatus which you say you built in accordance with the Figure 2 of this Lehr patent?

A. We built an impulse chamber similar to No. 4, using a piece of 4-inch pipe approximately 30 inches long; and then for a microphone we used a simple carbon microphone from the telephone, connected into the amplifier which you see on the floor there, the regular amplifier and recording mechanism which we use on commercial jobs. I have here in the courtroom the pressure cylinder that I used.

(Testimony of Randolph W. Cornes.)

Q. Will you please demonstrate that or just show it to the court?

A. This is the impulse chamber here, consisting of the chamber pipe, and then the valve mechanism for quickly releasing the gas in the chamber into the well, giving impulse. This large valve is the quick-opening top valve here. This end of the valve was attached onto the well and this small valve here was used for putting gas into the chamber under pressure.

Q. Did you ever connect this apparatus up to an oil well and use it to determine well depths of fluid or obstructions?

A. We used it on a test well in Duncan to make these measurements. The impulse chamber 4 was connected into the casing as is shown in Figure 2 in the drawings of the patent. On the opposite side, as shown in that drawing, was connected a [298] carbon microphone.

Q. Did you ever use any other kind of microphone in this apparatus?

A. Yes. We used the hot-wire microphone, the same as we use in our commercial work.

Q. Did the test well have tubing in it?

A. Yes; it did.

Q. How deep was the test well?

A. Approximately 600 feet. It was not actually producing oil. It was one which was drilled for testing various types of equipment, but it was in construction the same as an oil well.

(Testimony of Randolph W. Cornes.)

Q. I hand the witness two graphs and ask him to explain what they are, if he can.

A. They are records made on this well, using the impulse chamber, and the one marked "regular set-up" was used with the hot-wire microphone; the other one, marked "No. 3 microphone" was used with an impulse chamber and a carbon microphone. This marked "no filter", the filter was not used on either one of those records. These were made with a pressure impulse chamber. They were made with apparatus constructed in accordance with Figure 2 of the Lehr patent, and they were tests that I ran myself.

Mr. Babcock: I offer these into evidence as Defendant's Exhibits F and G.

[Printer's Note: Defendant's Exhibits F and G are set out in full in the Book of Exhibits.]

The Court: F will be the hot-wire microphone recording on [299] this, and G will be the carbon microphone recording.

Mr. Babcock: F is the graph made with the Wyatt and Lehr apparatus.

The Court: It is the hot-wire recording, distinguished from the carbon microphone recording.

Mr. Babcock: Who else was present at the well when you made these tests, Exhibits F and G?

A Dr. Mackeown was present.

On these graphs F and G, echoes from tubing collars appear in both of them.

Q. I am handing the witness Exhibits F and G,

(Testimony of Randolph W. Cornes.)

and ask him to mark on each of these the point indicated on each as to when the quick-opening valve was opened to allow the gas from the pressure impulse cylinder to enter the well. The exhibits are marked "Valve opened" at the point at which the valve was opened to release the impulse of gas. I have put an arrow at the point designated.

Q. Please place on each of these exhibits a large arrow indicating which way the paper was traveling in making these charts.

A. The charts are marked with a large arrow indicating the direction in which the paper traveled, and the arrow is labeled "Paper travel".

Q. Will you also mark each of these exhibits at the point [300] where the fluid level echo returned from the well?

A. I have done so and marked it "Fluid level echo".

Q. Will you please mark on each of these exhibits F and G, as by means of a bracket, where the echoes from tubing collars appear?

A. I have done this and marked the bracket "Tubing collar echoes".

Q. Do you recall what the conditions at the test well were when you made these graphs Exhibits F and G? First, do you know what size casing and tubing?

A. The casing was approximately of 5 inches inside diameter and the tubing was standard 2-inch tubing, the joints about 30 feet long.

(Testimony of Randolph W. Cornes.)

Q. Did the well have fluid in it?

A. Yes; the well had fluid at the bottom.

Q. As far as fluid level determinations are concerned, were the conditions the same as exist in an ordinary oil well? A. Yes, they were.

Q. When you made these charts, Exhibits F and G, did you make any other charts with the same Wyatt and Lehr apparatus?

A. Yes; there were a number of charts made at this time.

Mr. Mattingly: Mr. Babcock, will it be understood that the references to the Wyatt and Lehr apparatus which you are making here is the apparatus constructed by Mr. Cornes, and does not necessarily mean the apparatus of the patent? [301]

Mr. Babcock: Well, the witness has testified that it is; but that is correct, that is what I am referring to, the apparatus the witness built.

Mr. Mattingly: That is correct.

Mr. Babcock: Built like the Wyatt and Lehr Figure 2 of the patent.

Q. These graphs, Exhibits F and G, indicate where the fluid level was in that test well?

A. Yes, they do.

Q. In experimenting with this Wyatt and Lehr apparatus did you ever employ different gas pressures in the pressure impulse chamber?

A. Yes, we did.

Q. What difference in result did you get?

A. The results were all very similar, and the differences in intensity of the wave picked up could

(Testimony of Randolph W. Cornes.)

be sufficiently amplified by the amplifier to give a good record in all cases.

Q. I gather that when you used the low pressure in the pressure impulse chamber the echoes were not so strong and required greater amplification by your electric amplifier.

A. That is what I meant, yes.

Q. And when the pressure in the pressure impulse chamber was higher it required less electrical amplification to make a good record?

A. Yes. [302]

Mr. Babcock: I hand the witness a photograph which I will ask the clerk to mark for purposes of identification as Defendant's Exhibit H.

Q. Please state what it is.

A. That is an illustration showing the Wyatt and Lehr apparatus attached to the well in Duncan, on which these tests were made. That is using the Wyatt and Lehr chamber with the hot wire microphone. That is the Wyatt and Lehr apparatus we have talked about. The pressure chamber is above and to the left of the box containing the recording equipment. It is the cylinder with the gauge attached. Immediately to the right of the pressure impulse chamber is the quick-opening valve. On the right-hand side of the casing is, first, attached a butterfly valve, and then beyond that is the hot-wire microphone. The hot-wire microphone was connected through the cable to the recording and amplifying apparatus in the center of the picture.

(Testimony of Randolph W. Cornes.)

Q. Was any filter used in any of these tes with the Wyatt and Lehr apparatus?

A. No filter was used in the Exhibits F and

Q. And the amplifying and recording apparatu is that in the box shown just to the front and the left of the casing of the well?

A. That is right.

Q. I will ask the witness to mark in ink on th photograph Exhibit H the pressure impulse char ber. Mark it "H-1". Mark the [303] quick-ope ing valve "H-2". The casing of the well "H-3 The butterfly valve "H-4". The hot-wire micr phone, or where it is in the pipe "H-5". And th box containing the amplifier and recorder "H-6".

A. I have done so.

Mr. Babcock: I have asked the clerk to mar another photograph for identification as Defen ant's Exhibit I.

Q. I hand this to the witness and ask him state what it is.

A. This is an illustration showing the Wya and Lehr apparatus, using the carbon microphon attached to the well in Duncan.

Q. Is this apparatus the same as that shown Exhibit H, except for the difference in the micr phone?

A. Yes; it is. The carbon microphone is in th pipe fitting just under and slightly to the righ of the hand holding a ruler. It is placed in th same place in the mechanism that the hot-wire m crophone was placed in the apparatus shown

(Testimony of Randolph W. Cornes.)

Exhibit H. The man in the photograph is Dr. Mackeown. The pressure impulse chamber shown in Exhibits H and I is the same piece of apparatus which is here in the court room and which I described to the Court.

Mr. Babcock: Since these tests were made ex parte and at Duncan, Oklahoma, I wish to make this offer on the record: We will repeat the experiments or tests with this apparatus in the presence of counsel or other designated party for the plaintiff, or in the presence of the Court if the Court cares to watch them [304] on some well here in California, at a time that can conveniently be arranged, if the Court or the counsel for plaintiffs so request.

I have one other photograph which I will ask the clerk to mark for identification as Defendant's Exhibit J.

Q. This appears to be a photograph of the defendant's commercial apparatus here in court; is that correct?

A. Yes, it is. This is a photograph of the exact apparatus, the exact piece of apparatus here in court.

Q. Will you please mark on this photograph, Exhibit J, with a pen, the following: Mark the gun with the numeral "J-1". Mark the Y-pipe "J-2". Mark the coupling connecting the gun to the Y-pipe "J-3". Mark the butterfly valve in the upper branch of the Y-pipe "J-4". Just to the

(Testimony of Randolph W. Cornes.)

right of the butterfly valve is another coupling. that the one that contains the hot-wire microphon

A. Yes, it is.

Q. Mark that "J-5". Mark the surge chamb "J-6". The pressure gauge "J-7". And the b containing the amplifier, filter and recorder "J-8

A. I have done so.

Cross Examination

By Mr. Mattingly: Q. Mr. Cornes, I belie you testified you were in charge of Echo-Meter d vision of the Halliburton Oil [305] Well Cementi Company, is that correct?

A. Yes; I am. I am in charge of the maki of fluid level tests with the Echo-Meter apparat used by Halliburton Oil Well Cementing Compan and I am also in charge of the making of pressu determinations and maximum production determin tions of oil wells, using the Echo-Meter apparatu

Q. And you are in charge also of the maki of density determinations with that Echo-Met apparatus, if, as, and when the density determin tions are made with that apparatus?

A. Well, we don't make them.

Q. Does the Halliburton Oil Well Cementi Company make density determinations, using t Echo-Meter apparatus?

A. Not to my knowledge.

Q. Do you know of any instance in which t Echo-Meter apparatus has been used by the Hall burton Oil Well Cementing Company in the ma ing of density determinations?

(Testimony of Randolph W. Cornes.)

A. I don't know of any to my own knowledge that have been made. Some have been pointed out, some were turned over to us that apparently had been made.

Q. What do you mean by "some have been turned over to us"?

A. Well, I have seen several copies of reports which supposedly were made by our men, which were presented by the plaintiffs.

Mr. Babcock: Q. You mean in this lawsuit?

A. Yes, that is right; in this lawsuit. [306]

Mr. Mattingly: How long have you been connected with the Echo-Meter business?

A. I have been with Halliburton since August of 1940.

Q. And did you have any connection with the Echo-Meter business prior to that time?

A. With International Geophysics; yes. I was with them for just over three years prior to that time.

Q. Did you go with the Halliburton Oil Well Cementing Company at the time they purchased the Echo-Meter business from the International Geophysics, Inc.? A. No, I did not.

Q. When did you start work with the International Geophysics, Inc.?

A. Along in November of 1937.

Q. And were you employed by the International Geophysics continuously from that time until the sale of that business to the Halliburton Oil Well Cementing Company? A. Yes.

(Testimony of Randolph W. Cornes.)

Q. While you were employed by the International Geophysics, Inc., was the business of that company known as the Echo-Meter business?

A. A part of the busines of International Geophysics was Echo-Meter business.

Q. And that part of the business which was known as the Echo-Meter business relates to the use of the same apparatus [307] and the practice of the same methods which are now being conducted by the Halliburton Oil Well Cementing Company under the name of Echo-Meter business?

A. The method and apparatus are substantially the same.

Q. I refer you to the enlarged drawing, Exhibit 14 for identification, and ask whether or not that drawing is a correct representation of the casing-head unit which was demonstrated to the Court yesterday in the demonstration made by you?

A. There are slight differenees in construction, but it is substantially the same unit.

Q. And in the demonstration apparatus which you demonstrated yesterday, the gun which you demonstrated is pictured at 10 on this drawing Exhibit 14? A. Yes.

Q. And the part marked 11 on drawing, Exhibit 14, is that part on the demonstration Exhibit? A. Yes; it is.

Q. That is the electrical firing solenoid which is contained in the outer end of the gun mechanism of the demonstration unit here?

A. That is right. That equipment is all one

(Testimony of Randolph W. Cornes.)

diameter, rather than having a change as the drawing shows.

Q. But in so far as the construction and its operation is concerned, the picturization of that in Exhibit 14 is the same as the demonstration exhibit? [308]

A. This valve here is not on the demonstration exhibit.

Mr. Babcock: The witness is pointing to a valve immediately below the numeral 10 on the chart marked Exhibit 14.

A. And the pressure gauge 15 is not mounted on that unit now. Otherwise, I believe it is the same.

Mr. Mattingly: Q. The Y-pipe fitting referred to as 9 is the same as the Y-fitting which you have in the demonstration apparatus here?

A. It has the same function; yes.

Q. And that is merely a piece of pipe with two branches, is that correct?

A. In that unit there, there are several pieces attached to the branch, but that is the purpose of the pipe.

Q. But the Y-fitting itself is merely a piece of pipe with two branches to it? And that is the same as pictured on Exhibit 14 by this Y-pipe fitting 9?

A. Yes.

Q. There is nothing inside of that Y-fitting in the demonstration apparatus, is there? I am referring only to the Y-pipe fitting, not to the parts that are connecting or connected to it.

(Testimony of Randolph W. Cornes.)

A. In that fitting on the floor there are a number of quarter-inch pipes inside of the branch to which the gun is connected, and the other branch to which the microphone is connected, of course, has the butterfly valve. [309]

Q. And the number of quarter-inch pipes which you say are in one branch of that fitting, what is the purpose of that?

A. Those are what are normally called flame arresters. They are to cool gases from the shot and to catch or break up the wadding from the shot. It is just a safety measure. The equipment operates equally well without it.

Q. And the butterfly valve which you referred to that is in the other branch of the Y-pipe fitting on that demonstration model here is pictured on Exhibit 14 as being connected to the Y-pipe fitting 9, instead of being mounted directly in it?

A. Yes; that is right.

Q. As in the demonstration model. But otherwise, the structure and its operation of the Y-fitting are pictured on Exhibit 14, is that correct?

A. Yes.

Q. In Exhibit 14 there is a piece of pipe or a pipe fitting marked 14. Is that piece on the demonstration model here?

A. Yes; it is. Well, it is in a slightly different position. The manner in which the microphone is electrically connected to the unit on the floor is reversed from the way it is in Exhibit 14, merely as a matter of convenience in structure.

(Testimony of Randolph W. Cornes.)

Q. But the general construction and the operation of the microphone 18 and the electrical connection box 16, as pictured on Exhibit 14, are the same as on the demonstration model, is that correct?

[310]

A. Yes.

Q. And the surge chamber 17 which is marked on Exhibit 14 is the same as the surge chamber which you have in the demonstration model?

A. Yes; for the same purpose. It is a different diameter.

Q. And the connection from the bottom of the pipe fitting, of the Y-fitting 9, to the casinghead of the well, as indicated at 7 on Exhibit 14, is the same in its operation as the connection on the demonstration model here between the Y-fitting and the end of the rubber hose used in the demonstration yesterday, is that correct?

A. The size and the manner of connection, of course, differs, but the operation is the same.

Q. In other words, the demonstration model has a fitting which adapts the demonstration model to be connected to the end of a rubber hose; whereas, in Exhibit 14, the fitting which adapts the Y-pipe fitting to be connected to the casing of the well is the same in its structure except for the fact that there are shown valves and curved pipe fittings to make that connection, is that correct?

A. Yes; it is.

Q. And the only purpose of the valves and curved pipe fittings, as shown in Exhibit 14, is to

(Testimony of Randolph W. Cornes.)

make a connection between the Y-pipe fitting and the inside of the casing of the well so [311] that the waves will be able to pass from the Y-fitting down down into the well casing and the echoes will be able to pass back up to the microphone in the casinghead unit? A. That is right.

Q. Does Exhibit 14 represent to you a correct and accurate picture of the defendant's apparatus as it would appear connected to a typical oil well in the field such as you would use in making an actual fluid level test in the field?

A. It is correct as a diagram. It is not an exact illustration, of course, that you would have in a picture. There are slight constructional differences in the shape of the box, etc.

Q. And the oil well representation which is made on Exhibit 14, showing a well bore, a well casing, a string of tubing inside the well casing, the collars or joints in the tubing, the tubing catcher, the sucker rods going down through the tubing, the representation of the pump, is a diagrammatic representation of a real oil well, is that correct?

A. Yes, it is.

Q. Such as that upon which the defendant would and does make fluid level determinations?

A. Yes.

Q. And that representation which is made on Exhibit 14 of the transducer box 21 contains the electrical amplifier and the filter which you testified yesterday was in this box on the floor in the

(Testimony of Randolph W. Cornes.)

court room, connected to the gun and microphone in the [312] demonstration model, is that correct?

A. Yes; it is.

Q. And the recorder box which is indicated at 22 on the Exhibit 14, that is a representation of the recorder which is also contained in the box on the floor of the court room of the demonstration model to which we have just referred, is that correct? A. Yes; it is.

Q. In the demonstration that you made yesterday a record was produced. That record is Exhibit C. Will you look at that record and tell me what are the curves or wiggles in that line immediately to the right of the large wiggle that you have marked "End of hose"?

A. That is a part of the characterstic marking from any reflection. I think you will find that on most records, that you get a kick in one direction representing a reflection, and then there will be a movement back and forth following that.

Q. How did you recognize that mark which you have indicated as "End of hose"? How did you recognize that as the end of the hose?

A. Because it is a steeper mark than those preceding it and is characteristic of that type of reflection.

Q. Can you explain what you mean by "it is characteristic of that type of reflection"? [313]

A. Well, you would get the same or very similar reflection from the fluid level where you were working on a well.

(Testimony of Randolph W. Cornes.)

Q. Then, that mark might mean fluid level, instead of "End of hose", is that right?

A. Well, it would be the same thing. It is just the bottom, as far as you can go.

Q. You also picked out another one of the wiggles in that line and marked that "Coupling echo". Will you tell us how you could identify that little wiggle from the rest of the little wiggles to call it a coupling echo?

A. I identify it by its position and also because it is slightly larger than some of the other movements there which are probably caused by noise, extraneous movements of sounds picked up.

Q. Do I understand you to mean by that that it was half way between the shot—half way between the point you marked "Shot" and the point you marked "End of hose"? A. Yes.

Q. In other words, you knew the coupling was half way along the hose and therefore you could pick out a wiggle about half way between the "Shot" and the "End of hose" marks, and you assumed that that was the coupling, is that right?

A. Yes; that's right.

Q. If you had not known where that coupling was with reference to the hose, do you think you would have been able to pick out one of the wiggles and definitely know it was a coupling?

A. I think I would. [314]

Q. Wouldn't the wiggle that you have marked "End of hose (2)" also look like the echo or a

(Testimony of Randolph W. Cornes.)

record that you got from the coupling or that you have identified as the coupling echo?

A. It looks similar, but it is in the wrong position.

Q. You mean it is in the wrong position along the tape? A. Yes.

Q. To be the coupling echo. So that in picking the "Coupling echo" and the "End of hose" and "End of hose (2)" you selected those particular points merely by their position along the record strip, is that right? A. Yes, it is.

Q. These other wiggles which the court asked you about yesterday, lying between the mark "End of hose" and the mark "End of hose (2)", they also look like coupling echoes, don't they?

A. They are somewhat similar.

Q. If you had not seen this piece of hose and you had not conducted the experiment, but you had been merely given this chart, would you have said that those extra wiggles were probably coupling echoes? A. No; I wouldn't.

Q. However, they do look the same as the other echoes that you picked out up here and marked "coupling echoes", don't they?

A. Yes; they look similar. [315]

Q. So unless you knew in advance what the length of that hose was and where the coupling was located along the hose, you would not have been able to pick out one of those little wiggles and say "That is the coupling echo", would you?

A. I wouldn't say definitely—if I hadn't known the length of the hose, I wouldn't definitely know

(Testimony of Randolph W. Cornes.)

that this first echo mark marked "Coupling echo" was a coupling echo; but from the characteristic of the "End of hose" section, I think I would not have placed any emphasis at all on these following, because the amplitude of those was too small, and knowing how the equipment operates and being familiar with the interpretation of records, you would naturally not place any emphasis on those, you would not necessarily need to know all about the hose to throw those out.

Q. If there had been a hole in the hose somewhere along its length would that hole have registered an echo on the record strip?

A. If it had been of sufficient size.

Q. And would the record of that be any different from the record of the coupling?

A. It would probably look the same. I have never tried that but I would say that it would be similar.

Q. Can you tell us whether or not in the Echo-Meter apparatus the defendant uses the records which you get back from a well show obstructions extending into the well and they also [316] show records of enlargements which may be in the well, do they not?

A. Yes; they show reflection from either type of change in the diameter.

Q. Do those records of those two different things show up in the Echo-Meter records differently, or do they look alike?

(Testimony of Randolph W. Cornes.)

A. Reflections of the same amplitude would look about the same.

Mr. Babcock: Q. Are you familiar enough with the plaintiffs' apparatus, the Depthograph, to know whether that would be true with their apparatus?

A. I believe on their apparatus a reflection from an enlargement would represent a movement in the opposite direction.

Q. In other words, with their apparatus a reflection from a hole in the pipe would show up differently from a reflection from the collar?

A. Yes; it would.

Q. And how about as to the Echo-Meter?

A. They would show up the same with the Echo-Meter?

Mr. Mattingly: Q. If this record chart had been shown to you and you had not been told anything about the conditions under which that chart was made, what would you have interpreted that chart to represent? Will you tell us that?

A. Well, it would look similar to a record made in a shallow well. [317]

Q. And the wiggles along the line there might represent coupling collar echoes—would you have understood them?

A. They could, but very seldom in a shallow well do you get particularly good reflections; that is, when you get too shallow they are difficult to pick out.

(Testimony of Randolph W. Cornes.)

Q. Yesterday you testified about some tests that were made at a Union Oil Company well at Dominguez and you produced some record strips that were made at the time that demonstration tests were conducted. Do you know how deep that well was?

A. You mean total depth of the well?

Q. Yes. A. No; I do not.

Q. Do you know what size the tubing was in the well?

A. No; not exactly. Either two or two and one-half. I don't recall. I don't remember whether I asked or not.

Q. Do you remember what the size of the casing was in that well?

A. I think it was approximately 6 or 7 inches, but I didn't pay any particular attention.

Q. That well was static, was it not, at the time these tests were made? A. Yes; it was.

Q. And by that do we both mean the same thing, that the pump was not running at the time the tests were being made? [318]

A. The pump was not running and the casing was closed in and supposedly the tubing was also closed. By "closed in" I mean shut off.

Q. The valve was closed on the well we had the demonstration test on, was that right?

A. Yes.

Q. And the tubing might also have had a valve in it, but that was closed, too, was that right?

A. I didn't check it, but it should have been closed.

(Testimony of Randolph W. Cornes.)

Q. Do you recall what the pressure was in the casinghead of the well at the time the demonstration test was made? A. Approximately 90 pounds.

Q. I refer you to Exhibit D. These record strips shown on Exhibit D are copies of the actual records which were made by the Echo-Meter apparatus at that well during that demonstration test, is that right? A. Yes, it is.

Q. The record strip No. 1 on Exhibit D shows a lot of wiggles along the line. What is each one of these wiggles?

A. Each of the wiggles between the "Shot" point and the "Fluid reflection" represents coupling collars, each of the larger wiggles, tubing collar reflections.

Q. And is the same thing true on the record strip 2? A. Yes, it is. [319]

Q. The first ten wiggles on record strip 1 and the first ten wiggles on record strip 2 represent echoes from exactly the same collars, is that correct?

A. Yes, sir. The same ten collars that are disposed immediately below the upper end of the well. The record strip 1 was made with the Echo-Meter apparatus with the filter out of the circuit. And the record strip 2 was made by the Echo-Meter apparatus with the filter in the circuit and set correctly for the frequency of the collar echoes in that particular well.

Q. And the collar echoes which appear on record strip 2 are not represented as strongly as those on record strip 1, are they? A. No; they are not.

(Testimony of Randolph W. Cornes.)

Q. Then the tuning of the recorder there did not have much effect on bringing out or amplifying those tubing collar echoes, did it? A. No.

Mr. Babcock: Q. Was the amplifier set the same in charts 1 and 2?

A. Approximately the same. I don't remember exactly what the settings were. There might have been some difference there.

Mr. Mattingly: Q. So far as you know, the amplifier was set the same in both cases?

A. No; I wouldn't say so. I would say it was almost the [320] same. There might have been considerable difference in amplification between the two.

Q. In other words, the strip 1 might have been made with the amplifier set at one value and strip 2 with the amplifier set at a different value?

A. The value was probably changed throughout each of those records as they were being made. In other words, starting at a low value and increasing it.

Q. But that did not have anything to do with the frequency setting?

A. No. After the shot was fired during the time that the apparatus was running and in between the firing of the shot and the echo from the fluid reflection I may have changed the amount of amplification on each of these charts 1 and 2.

Q. But as far as you know, the starting value of the amplification and the end value of the amplification in both strips was the same, was it not?

(Testimony of Randolph W. Cornes.)

A. No. We made no record of either the starting or the end values, and I don't remember. They probably were not the same at the end, even though they might have been the same at the start.

Mr. Babcock: I would like to put this on the record: Counsel, I take it, is referring on all these charts to the "kicks", let us call them, between the shot and the first fluid level [321] reflection in referring to these tubing collar echoes, are you not?

Mr. Mattingly: That is right. And I think, for the convenience of the Court in determining just what reflections we are referring to, I would like to have the witness mark Exhibit D to indicate the beginning of the recording of the echoes.

A. I have marked the "Shot point" on each of these six records, marked it "Shot".

Q. I believe you testified that in the practice of the defendant in finding fluid reflections with the Echo-Meter apparatus, they did not always use a filter in the circuit, is that right? A. Yes.

Q. How do you determine whether you are going to use the filter in the circuit or not?

A. From the appearance of the first record which is made without the filter. The first record (Chart 1 of Exhibit D) here shows uniform and distinct collar reflections. These are sufficiently distinct so that there would be no particular need of using the filter. However, in some cases the collars may not be distinct, there may be other reflections, minor reflections or noises in the well, minor reflections from dirt or casing collars or something else in the

(Testimony of Randolph W. Cornes.)

well, and which would cause the record to be indistinct and hard to read. In that case it would [322] probably be advisable and help to use the filter in the well.

Q. That would be if you would fire a first shot into the well, make a record, take a look at that record, and if the collar echoes were distinct, then you would not use the filter, is that right?

A. Yes, there would be no need to. Some operators have a habit of using it, and others don't like it at all. But if they were distinct there was no reason to use it.

Q. And then if you fired your shot and the collar echoes, that is, your wiggles in the line, were so you couldn't tell whether they were collar echoes or not, then you would fire another shot and use your filter in the circuit, is that correct?

A. Yes. You would figure out your filter setting from the first record and use it in the second one to see whether there was any improvement.

Q. So when you say you don't always use it, you mean that there are some conditions in oil wells under which you will make a record that you do not necessarily require the filter, is that right?

A. Yes.

Q. But in most of the wells that your company measures with the Echo-Meter apparatus you do use the filter in the circuit?

A. No. I would not say in the most, probably less than half. I never counted the records and don't know exactly, but I know in Kansas, where

(Testimony of Randolph W. Cornes.)

the large percentage of our work is done, [323] the operators there do not use the filter at all. Some of them have even taken it out of their instruments. In some areas it is used more than others. It somewhat depends upon the preference of the operator as to whether he wants to try it or not.

Q. Does the filter which is used by the defendant filter and amplify frequency which is produced by reflections from the tubing collars?

A. The filter does not do any amplifying. The amplifier does all the amplifying, and the filter or feed back circuit, which accomplishes what we call the filtering, merely reduces the intensity of echoes arriving at some other frequency than the tubing collar echoes.

Q. But the filter does not amplify or cause the tubing collar echoes to be amplified more than they would be if the filter was not used, is that right?

A. Generally, the intensity is even reduced over what it would be without the filter, with the same amplifier setting.

Q. I believe you described yesterday a control knob or handle on the instrument which was demonstrated in the court room here that was used to adjust the filter, is that correct?

A. That is used in that instrument on the floor. It is used to turn the filter on and adjust the setting.

Q. And does that knob adjust the frequency to which the filter will respond?

A. Yes; it does. [324]

(Testimony of Randolph W. Cornes.)

Mr. Babcock: Q. Let me ask what determines the frequency of these echoes.

A. The frequency of the echoes is determined by the spacing of the collar on the pipe and by the velocity of sound in the pipe. The filter setting, the actual calibration is calibrated in millimeter spacing between reflections. No reference is made on the instrument to frequency. The original calibration is—well, it is not even then made in terms of frequency exactly. If you are putting in an oscillator a certain wave, you could set that for a certain frequency, but in the field no reference is made to the frequency; it is made to collar spacing. The calibration of that instrument makes no reference to frequency.

Mr. Mattingly: I didn't ask about the calibration on the instrument. I merely asked: Does the control knob of this filter adjust the frequency to which that filter will respond? A. It does, yes.

Q. That is the nature of the construction of the filter, isn't it?

A. That is right. All filters are concerned with frequencies.

Q. Does this filter act with the amplifier to cause the amplifier to have a tendency to oscillate at the frequency for which the knob is set?

Mr. Babcock: I believe I will object to that question, [325] unless you ask him first if an amplifier oscillates.

A. An amplifier will pass the frequency for

(Testimony of Randolph W. Cornes.)

which the knob is set; so far as oscillating by itself, it shouldn't do that.

Q. But the amplifier has a natural tendency to oscillate at the frequency of these tubing collar echoes which come back from the well and for which frequency of tubing collar echoes your filter collar has been set; is that correct?

A. No amplifier should oscillate. I don't think that one has a tendency—could be said to have a tendency to oscillate, that is, it won't oscillate of its own accord.

Q. But it will oscillate to frequencies for which the filter has been set, will it not?

A. No; I don't think it would. To oscillate it would have to keep going by itself, and it won't do that.

Q. Doesn't the filter that is used by the defendant select out a certain limited narrow band of frequencies from all of the frequencies that are put into the amplifier, and then feed back into the amplifier those frequencies within that limited band?

A. Well, we are going into the electrical characteristics of the operation of the amplifier there. If you want a complete description, your description is not accurate there. The reverse actually happens. That is, approximately the reverse of what you stated.

Q. Will you state what does happen?

A. The filter is so constructed that the amplifier takes [326] what is picked up from the well and amplifies it through the three stages of the amplifier,

(Testimony of Randolph W. Cornes.)

and then those frequencies of signals to which the filter is not set to respond are fed back from the output of the amplifier to the second stage, I believe it is, of the amplifier, where they tend to cancel out those extraneous signals, and the signals for which the filter is set, the tubing collar, uniformly recurring tubing collar reflections are allowed to pass through the amplifier, but the intensity, though, is not increased by the filter. The amplifier does all the amplifying and the filter merely cancels out other signals.

Q. Did you have anything to do with the preparation of the construction book, Plaintiffs' Exhibit 11-C?

A. No; I did not. That is the field manual it is called.

Q. Do you know whether or not that book correctly describes the defendant's apparatus and the way it operates?

A. There are minor technical errors in there which an electrical engineer probably would not have put in; but so far as the field operation, the actual technique of taking fluid levels is concerned, I think the manual is substantially correct.

Q. Does the pressure of the gas in the casing-head of the well have any effect upon the clarity of the registration of tubing collar echoes?

A. I would make a general statement that it does. An increase in pressure generally reduces the amplification necessary to get [327] a record, but at

(Testimony of Randolph W. Cornes.)

times an increase in pressure may have a detrimental effect rather than it being advantageous.

Q. Does the length of the annular space in the well between the casinghead and the fluid surface affect the clarity with which your tubing collar echoes will register?

A. As the well gets deeper more amplification is necessary, and it is occasionally impossible to get tubing collar echoes to the bottom.

Q. And in the case of one of those deep wells like that, would that be one of the occasions when you would have to use your filter in order to bring out those tubing collar echoes?

A. It might make them more distinct and it might not. Generally, I think it would aid in counting, at least, those lower reflections.

Q. Were you present at Duncan at the time this instruction book 11-C was being written and compiled?

A. No; I was not employed by Halliburton at that time, that is; that is dated July, 1940, is that right?

Q. That is correct.

A. I started work for Halliburton on August 2, 1940.

Q. And that was after the book was completed?

A. That is right.

Q. Well, would you say that the description on page 13 of this book of the operation of the filter of the defendant is a correct statement? [328]

(Testimony of Randolph W. Cornes.)

A. So far as the electrical operation of the filter goes the statement is not correct.

Q. Do you know whether or not that was a correct statement of the operation of the apparatus which was used by the defendant at the time the book was written? A. It is not correct.

Q. Is it a correct statement of the apparatus and its operation as used by the defendant now?

A. No.

Mr. Babcock: Q. In your previous testimony you have given the correct operation of the filter, haven't you?

A. I think I have pointed out most of the points regarding the filter.

Mr. Mattingly: Q. Will you tell us how you know that that did not correctly describe the filter which was used by the defendant at the time the book was written, if you were not employed by the Halliburton Oil Well Cementing Company at that time?

A. The Halliburton Oil Well Cementing Company purchased all the instruments which they used up to that time from the International Geophysics, and I was employed by International Geophysics and constructed a large percentage of the instruments which Halliburton was using, and designed and introduced the filter into the instruments myself.

Q. So, you were the one who designed the filter in this apparatus? [329]

A. Yes; I designed or adapted it, that is, I adapted the circuit to the apparatus.

(Testimony of Randolph W. Cornes.)

Q. Do you know when that was first used?

A. Your question refers to when this type of filter circuit was first used in Echo-Meter equipment, do I understand?

Q. That is right.

A. About February, 1940. I don't remember the exact date. But we were experimenting with this equipment about that time.

Q. And has there been any radical change in the filter which was used in the Echo-Meter apparatus since that time?

A. The filter equipment used in all of the instruments in the field at that time was substantially the same. In this smaller instrument on the floor one of the controls was left off. Just a fixed setting was used on what is called the Decrement control in the manual, and the on and off switch was combined with the other control. But the circuit and operation is substantially the same and has been since it was first produced.

Q. You were with the International Geophysics in February, 1940?

A. Yes. I left them toward the end of July in 1940 and went with the Halliburton Oil Well Cementing Company within a week or ten days, so that throughout this entire period of time I was thoroughly familiar with the Echo-Meter apparatus and the filter. I was employed by the International Geophysics company during the late summer and fall of 1939. [330]

(Testimony of Randolph W. Cornes.)

Q. Do you know whether or not during that time this Echo-Meter equipment was being used to test or find fluid levels in wells at Huntington Beach for the Standard Oil Company?

Mr. Babcock: This matter was not touched on in direct examination.

Mr. Mattingly: Well, that is true. Then, if you want to put in an objection based upon that you may do so.

Mr. Babcock: Well, go ahead; he is your witness.

A. We did several days', or maybe weeks', work down there at Huntington Beach for the Standard. A charge was not made for part, and perhaps for any of that. I don't know.

Mr. Mattingly: Q. Do you know why there was no charge made for that?

A. The type of well they had there was quite different to work on, and we were not satisfied, and neither were they, with the operation at that time, that is, the results that we and they were getting.

Q. Do you know why those results were not satisfactory?

A. It was a combination of factors. I think they gave us insufficient well data to work with, and we were not absolutely satisfied with the fluid reflections which we were getting. In other words, we did not have sufficient confidence in our data to want to turn it over to them as commercial operations.

Q. Do you know whether or not the records that you obtained in those wells distinguished tubing

(Testimony of Randolph W. Cornes.)

collar echoes from fluid level [331] echoes and other noise echoes?

A. You want to know if the fluid level reflections were distinguished from tubing collar reflections?

Q. And other noises in the well.

A. As I remember it, in general we got very good tubing collar reflections. The principal trouble on those wells was that they had a catcher and liner set in practically all of them and we had some difficulty in distinguishing fluid level from the liner, and since they are both the same type of reflection and they in some instances did not give us correct data on the depth of the liner—I don't remember the number of the well, but on several wells the liners were set when the wells were first drilled and their records seemed to be in error. But so far as getting tubing collars and knowing they were tubing collars, I think the results were quite satisfactory.

Q. I refer you to Exhibit 11-C, the sheet of drawings which appears immediately in front of page 14 of that exhibit, and ask whether or not the wiring diagram which is shown on that drawing is a correct representation of the wiring employed by the defendant in its filter on its Echo-Meter apparatus? In other words, is that drawing right?

A. That drawing is right for the instruments in which it was used, which includes all the instruments up until this smaller instrument here in court was constructed. The circuit of that is the same as this, except for differences of the values. [332] That was constructed some time during the spring of 1942.

(Testimony of Randolph W. Cornes.)

Q. And the defendant is still using in the field instruments which include a filter corresponding to the diagram which appears before page 14 of this book, Exhibit 11-C? A. That is right.

Q. And will you also look at the two diagrams which appear immediately following page 11, the first two sheets immediately following page 11 of Exhibit 11-C, and state whether or not those diagrams are a correct representation of the circuits employed by the defendant in its Echo-Meter apparatus? A. Yes; they are.

Q. And those diagrams are correct for the amplifier apparatus shown now in the new instrument which you have just pointed out?

A. No. They are correct for the older instruments. There are some changes in the new instrument which is now on the floor.

Mr. Mattingly: That is all.

Redirect Examination

Mr. Babcock: Q. You have just referred to these diagrams here on the amplifier following page 11. Is there anything essentially different in those diagrams and the actual apparatus here in the courtroom as to the amplifier?

A. So far as the performance of the amplifier goes the two are essentially the same. There is differences in values and difference in the coupling between some of the amplifier stages. [333]

Mr. Graham: I offer in evidence Exhibits H and I, which are photographs showing Wyatt and Lehr apparatus, attached to the well in Duncan.

(Testimony of Randolph W. Cornes.)

I offer as Exhibit J, a photograph of defendant's commercial apparatus, that we had here in the court room.

The apparatus of Exhibits H and I were built by the witness Cornes or under his direction, for these experiments that were made at Duncan, Oklahoma.

The Court: From the specifications set forth in the Wyatt and Lehr patent?

Mr. Graham: According to that, your Honor.

The Court: They are in evidence as defendant's exhibits, and so received.

Mr. Mattingly: At this time, I would like to offer the enlarged drawing, Exhibit 14, which is on the easel, as Plaintiffs' Exhibit 14, and Exhibit 15, the record strip which the witness testified was made on the apparatus in accordance with the photograph Exhibit H. Then as Plaintiffs' Exhibit 16, a group of other record strips which were made with the apparatus, as shown in Exhibits H and I.

[Printer's Note: Defendant's Exhibits H, I, J, are set out in full in the Book of Exhibits.]

[Printer's Note: Plaintiffs' Exhibit No. 14 is set out in full in the Book of Exhibits.] [334]

SAMUEL S. MACKEOWN

a witness on behalf of the defendant, testified as follows:

My address is 124 Arden Road, Pasadena. I graduated from Cornell University in 1917, major-

(Testimony of Samuel S. MacKeown.)

ing in science, and was admitted to the graduat school in the last part of that year, but in June o 1917 I accepted a position with the Bureau o Standards, in Washington, D. C. as laborator assistant. Some of my first work there was on sound ranging device for locating gun fire, whic shortly went overseas. Then I was transferred t work for the Signal Corps, and in March, 1918, was granted a commission as a second lieutenant i the Signal Corps, and assigned to duty at the devel opment laboratory at Camp Vail, New Jersey; tha is now Fort Mammoth; and had charge of experi mental work on the development of airplane radi receivers and transmitters.

In September of 1918 I was transferred to th office of the chief signal officer in Washington, D. C. in charge of development of new types of radi tubes for the Signal Corps. In February of 1919 I was discharged from the Army and returned tem porarily to the Bureau of Standards, in their radi division, as assistant physicist. In July of that year I accepted a position as a research engineer in the engineering department of the Western Electric Company. That is now the Bell Telephone Laboratories, Inc. In September, 1920, I returned to Cornell University as an instructor in physics, and was an instructor [335] in physics and a graduate student there until June, 1923, when I was granted the degree of Doctor of Philosophy, majoring in physics.

In September of 1923, I came to the California Institute of Technology as a national research fel-

(Testimony of Samuel S. MacKeown.)

low of the Rockefeller Foundation, which position I held until 1926. In the summer of 1926 I took a temporary position with the research staff of the Westinghouse Lamp Works at Bloomfield, New Jersey, and in the fall of 1926 I returned to the California Institute on the staff both in the physics department and electrical engineering. Since 1926 I have been at the California Institute of Technology, and have had charge of the work in radio, communications, sound recording, electronics and such fields.

My courses consist of courses in communications and certain filters, resonance circuits, and methods of recording sound, reproducing sounds, microphones, and so forth, and I am professor of electrical engineering in the California Institute of Technology.

I have been called during the past ten or twelve years by different companies to act as an expert and testify in a number of patent cases. Some of those have been the General Electric Company on Tungsten Filament. That was a case heard in this district, where testimony was taken before Mr. Head as Master for Judge McCormick, I believe; on the Neon Light patents [336] before Judge Cosgrove; before the late Judge James in the Technicolor case, and before Judge Yankwich in the Hookless Fastener case, that is the zipper; and several cases for the Western Electric Company, and the American Telephone and Telegraph Company, on sound recording, and by the Radio Corporation of America

(Testimony of Samuel S. MacKeown.)

on both sound recording and radio cases; and by the Halliburton Oil Well Cementing Company in a case before Judge Kennerly in Houston, on electrical logging of oil wells, that was the Schlumberger case. And this summer in a case by the Standard Oil Company on refining of gasoline and special means of controlling temperature.

Mr. Graham: Q. Doctor, at the present time are you connected with any of the technical departments of the armed forces?

A. Yes; I hold, and have held for the past six years a commission as lieutenant commander in the United States Naval Reserves.

I will discuss the patents in suit, particularly the technical points which may cause difficulty to one not familiar with sound and its properties.

In referring to Plaintiffs' Exhibit 1, which is patent 2,156,519, the first two paragraphs, I think need no explanation. There is nothing there that I think is of a technical nature that needs any explanation. I think it is plain to anybody. The paragraph starting on line 16 explains prior methods of determining [337] fluid levels, and divides those into two types. One type is with a line or pressure recorder, or a bailer is lowered into the well and the surface level is determined by the amount of line which has to be let out until the line makes contact with the fluid. It speaks about a pressure recorder, how this pressure recorder can be operated by a clock so that it can make a recrod of the pressure over a considerable period. Then

(Testimony of Samuel S. MacKeown.)

starting at line 37 it refers to the other old method, and I will read that sentence, the last of that paragraph:

"The other method is that of producing sound waves in the well and noting the elapsed time between the introduction of the sound and its return as an echo from the surface of the fluid or other obstruction encountered."

I would like to read the next paragraph before speaking about the sound method, and the differences between the sound wave and the pressure impulse, or possibly you might state it as sound inpulse. Referring to the old methods, the patent continues, on line 42:

"Neither of these methods is satisfactory, the first having the disadvantage of requiring the removal of oil flow tubing, sucker rods and other apparatus normally disposed in the well prior to the time the instrument is inserted in and lowered into the well, requiring a considerable length of time both for the removal of such apparatus, the reinsertion of the apparatus, and the making of the actual measurement." [338]

That is, if you are lowering a large bailer or large pressure recorder, it is necessary to remove the tubing. Then it continues:

"The other method is unsatisfactory primarily because of the relatively low intensity or energy which can be employed in the sound wave so that the echo received back is of such low energy as

(Testimony of Samuel S. MacKeown.)

to prevent its accurate detection and, further, little or no distinction is made by reason of such low energy between various types of obstructions encountered by sound waves."

The two objections are, first, that the energy in a sound wave, this patent states, is low, and second, that there is no characteristic variation or type of response which is characteristic of obstructions encountered by the sound wave. Then the next paragraph:

"A third method, namely, that of producing a shock of relatively high intensity in the well, creating thereby a pressure wave which travels through the well, and measuring the elapsed time between the introduction thereof and the echo thereof, to give an indication of the depth of the fluid level and other obstructions, has been introduced, one form being that of creating an explosion in the well, another form being illustrated and described in United States Letters Patent No. 2,047,974, issued to Harold J. Wyatt and Paul E. Lehr on July 21, 1936. This latter method has the desirable characteristic of permitting the [339] employment of relatively high intensity in the wave or impulse produced in the well and it is an object of my invention to improve upon the method disclosed in that patent and to eliminate or materially reduce factors of error encountered in the employment of that method."

There is seemingly, then, a distinction between sound methods and pressure impulse methods, and

(Testimony of Samuel S. MacKeown.)

I think it would be well to explain what a pressure impulse is and what a sound wave it, so that we can understand the distinction between these two methods.

A pressure impulse is a blast of air in one direction. You blow out through your lips, like that; you get a pressure impulse. A pressure impulse is generally a pressure only in one way. If I can step down to the board I think I can show the difference between these impulses better.

I will plot on the abscissa time. The time will be increased to the right and ordinate, pressure. This line through here will be the constant atmospheric pressure, or the pressure which might exist. I will mark that line A. Zero on this is a vacuum. A can also be referred to, as pressure in the casing before any disturbance is put in.

The Court: It is atmospheric pressure.

A. That casing might be higher than atmospheric pressure. It is whatever pressure is present in the chamber. The pressure impulse would be the pressure wave which might have a form like [340] this, which would always increase the pressure, and not cross its axis; in general, which may be an impulse, a unidirectional pressure. That pressure impulse can have a certain wave shape—I will draw another pressure impulse down here, which would be different. It might look like this, which would be obtained by, say, leaving a valve open for a greater length of time. The first impulse, we will mark it 1, would be the kind of impulse

(Testimony of Samuel S. MacKeown.)

you would get if you open a valve; there is a rather high pressure in that chamber; you close it quickly; then the pressure dies down, by closing the valve. The kind of impulse you can get with the pressure impulse shown on this would be where the magnitude of the actual pressure would be lower; maybe you did not open the valve as high, or maybe the chamber did not have as high a pressure in it, and you kept your valve open for a greater length of time. You can have a negative pressure, or rarefaction. The patent speaks of negative pressure waves, and Mr. Walker spoke about rarefaction, which can be obtained by reducing the pressure. We might have a casing of high atmospheric pressure, and reducing that pressure——

Mr. Graham: Q. May I ask you right there, Doctor, for instance, to illustrate that, if you have a casing pressure of 100 pounds, you open the valve quickly, and let some of that pressure out, that would be negative?

A. That would be negative pressure. [341]

The Court: With positive pressure you blow; with the other you suck?

A. That is right. That would be rarefaction or negative pressure. That would be just the converse of this; and we could have a pressure impulse existing, like No. 3, which would be a negative pressure impulse, or a rarefaction.

Plotting exactly the same thing down here, and marking this A again, for atmospheric pressure, a sound wave, without a pressure impulse, such as

(Testimony of Samuel S. MacKeown.)

would be produced by a stringed instrument, a violin, for instance, would be a wave which would have both a positive and a negative pressure, or a pressure and rarefaction wave crossing the normal or average pressure line, and the frequency of this wave, which is measured between the upper peaks would, of course, determine the pitch of the sound. Middle C, for instance, has a frequency of 256 variations per second, so there would be 256 complete waves or peaks above the line every second when middle C is sounded.

The Court: Above the line?

A. Above the line, not counting the peak below, and the frequency is from these two points from which I have drawn a line.

The Court: From peak to peak?

A. From peak to peak, or from crest to crest, and the distance there is spoken of as the wave length, and the number of those that occur per second is spoken of as frequency. This would be a pure sound wave, as I say, produced by a stringed [342] instrument such as a violin string, where it is excited by bowing. A great many of our instruments actually produce sound by pressure impulse, such as the trumpet, the clarinet, or any of those instruments, which do produce sound, a musical impulse, by an actual pressure impulse, a blast of air. In that case you would have a combination of a pressure impulse and a sound, so that when the sound began you would have this pressure impulse with the sound wave superimposed upon it.

(Testimony of Samuel S. MacKeown.)

The Court: Would that ever come down again, the pressure impulse?

A. This pressure impulse would not come down until the wave dies out. If the wave is excited by a pressure impulse, for instance, if you are blowing a trumpet or a whistle, the whistle is produced by the pressure impulse; the sound through your lips is superimposed on that. You do not realize it, but that is the pressure wave going out followed by a rarefaction wave. As long as that whistle goes you have to excite it by this pressure impulse.

I will mark this a positive pressure impulse. This would be a negative pressure impulse. This would be a sound wave. The lower one would be the sound wave, but you can distinguish between this one and the lower one by calling this a sound impulse. You will find that this is talked of in some cases as a sound impulse. [343]

The Court: What is a violin wave? That is the sound wave with a sine wave superimposed on it?

A. The wave for a violin wouldn't be any simple wave like this, but would have many irregularities superimposed on it.

Q. Following the other wave?

A. I will draw the last portion showing that. That might be a lot of variation superimposed on that.

Q. It would be superimposed on the regular other sound wave? A. Yes.

Q. So you will have two waves?

A. You will have a large number. You will

(Testimony of Samuel S. MacKeown.)

have actually as many as the eleventh harmonic. That is why, if you have the note C struck on the piano, and the note C played by a violin, of equal loudness, you still distinguish the two because of the presence of these harmonics or irregularities which give it the quality of sound which is distinctive, and gives the difference between a violin and a saxophone, and so forth, playing with the same loudness, in the presence of those harmonics.

Q. You call those sine waves?

A. Those are sine waves, but sine waves of a high frequency of harmonics. If this sine wave represents middle C the time between the peaks of this would correspond to 1/256 of a second. And in harmonics we would have also present a frequency of 512, which is the second harmonic. The harmonics are present in nearly [344] all musical instruments. If you don't have harmonics, it is rather a flat note, and they depend on the shape of your sound box and the construction of it, and the quality, the presence of those harmonics, in a manner that an artist thinks is proper. That is what distinguishes an expensive violin from a cheaper one, and gives the tonal qualities desired in an expensive violin.

I might point out that a sound wave, or sound —that the ear is able to hear from a frequency of approximately 16 per second up to, well, we might say 16,000. 16,000 is rather high. I can't hear much above 8,000 cycles. Some people hear up to 20,000,

(Testimony of Samuel S. MacKeown.)

but the average ear would be something like 16 up to 16,000.

The Court: That is the human ear?

A. That is the human ear. A dog will have a higher frequency than a cat. The ear has a terrific range; a range of about 1,000 octaves actually.

This patent then, this apparatus in this patent, as I understand it, is going to use a pressure impulse, shown on the top of the blackboard, rather than a sound wave, or sound impulse. Because in column 1 it speaks of the other method of producing sound waves. Most sound waves are produced by pressure impulse. All of your wind instruments are produced by pressure impulse—all of your wind instruments produce sound by pressure impulse. A gun also produces a pressure impulse.

[345]

A gun would produce a pressure impulse, and superimposed on that would be the sound waves, as shown in the bottom, and that would be followed by a rarefaction wave, after the first pressure wave. The gun is confined, and the wad and bullet move out, and that leaves rarefaction behind, and suction, and it is only the production of that suction that gives you the sound of the gun. The first blast moves out, and produces a vacuum; air rushes in; too much rushes in, and that produces a clap. That goes back and forth. That is the thing that gives the sound of a gun.

The Court: What about echoes?

(Testimony of Samuel S. MacKeown.)

A. Echoes are simply a reflection of sound waves or pressure impulses from any discontinuity. By that I mean, by any wall, or if they are in a tube, by any change in the diameter of the tube or by change in the material in the tube itself. But suppose we talk about these echoes—I will turn this board around—we were interested in sound in a tube, so let's think of that. Suppose we have a tube here, and if I do anything to change that tube, if I bent it around a corner I will get a reflection, or if I put a restriction in here and make this tube narrower, then if I have a pressure wave traveling to the right, when it reaches here there will be reflected back a pressure wave at this point. That would be an echo coming from this tube because of it constriction. [346]

The Court: Would the same thing come back from sound?

A. Sound would be reflected back. The amount, the per cent of the energy that is reflected back will depend on how big this restriction is, and the strength of the echo will be approximately equal to the per cent of the area that is cut off. That is, if I have a restriction here that decreases my area one-half, approximately one-half of the energy will be reflected back at that point.

The Court: Does that same rule apply to pressure impulses and sound impulses?

A. Yes, that same rule would apply to both of them. You would get the same effect. I might say particularly of sound traveling in a tube, we know

(Testimony of Samuel S. MacKeown.)

all about it, it having been worked out by Lord Rayleigh in 1870 or thereabouts. And we know the theory. We can tell you everything, practically, that happens in a theoretical case where we have a uniform tube.

The Court: When sound is introduced into a tube, isn't it the tendency to scramble it due to the echoes from the sides running into one another?

A. There will be that scrambling at the entrance end after the sound is in the tube. After the sound is in the tube it will travel through here and with a loss decreasing in magnitude due to energy losses through the tube. But if the tube remains the same; that is, not a change in diameter or material in it, then this will continue down there, gradually decreasing [347] in size with no scrambling.

The Court: Do these pressure impulses travel at the same rate of speed as sound impulses?

A. They do, yes. The speed is determined entirely by the properties of the gas. They are both what we speak of as pressure impulses or waves.

The Court: What is the difference?

A. The difference is that a pressure impulse is something which we always think of as a pressure increase and never a rarefaction wave. A sound wave is a succession of pressure increases and decreases or waves followed by rarefaction waves, and so forth. They follow very rapidly. I mean, sound waves we speak of in the audible range. The

(Testimony of Samuel S. MacKeown.)

average frequency would be something around 1000 or 2000 cycles.

The Court: If a pressure impuse is introduced into a hollow metal tube, doesn't that create sound, however insignificant? It may not be audible to me, but doesn't it create sound?

A. If you had a pure pressure impulse introduced into a tube, I would say there would be no sound there. It may be difficult, experimentally, to get no sound. It might be a small hiss, but I would say, if it was a pure pressure impulse that there would be no sound. If I blow through my lips you will hear very little sound, but I put my lips close together and I can whistle. Then I have a sound. But if you say, a pure pressure impulse, I would say there was no sound. And if you [348] say a pressure impulse, I would say that that was something in which the sound was very small. It might be a sound from gas escaping through the valve. The impulse would be very large compared to that.

The Court: If the pressure impulse were relleased into the open air there would be less sound than if it were introduced into a hollow metal tube, wouldn't there?

A. No, there would not. It would be only a vibration of the air in the valve. That would be a function, entirely of the opening, the amount of sound wave introduced. It would not make any difference at what rate it was introduced.

The Court: All right.

(Testimony of Samuel S. MacKeown.)

Mr. Graham: Q. On that question: the sound waves are in the audible range, and pressure waves are not?

A. Pressure waves—I don't think we ought to say pressure wave. We ought to say pressure waves coming in one direction. Because a sound wave is a pressure wave in rapid succession. But a pressure impulse, I think, is not a wave. It is all in one direction.

The Court: I would like to hear a pressure impulse introduced into a chamber.

The Witness: We have the apparatus here. We can do that. I don't know what we can introduce it into. We haven't a casing here to introduce it into. We have a hose. [349]

The Court: I am thinking of tuning in a different sense than you people are, apparently. I understood Dr. Mackeown to say there wasn't any sound. I have always had an idea that there was. Maybe I have been hearing things.

The Witness: Your Honor, I said a pressure impulse is something where the sound would be small compared to the pressure impulse. As I said, if you had a pure pressure impulse I would say you had no sound. But practically you will have from that big pressure impulse, some small amount of sound, such as the hiss due to the opening of the valve which, however, is incidental. If you blow through your lips that is a good illustration.

The Court: Well, I have got to decide whether or not the pressure impulse used by the plaintiff

(Testimony of Samuel S. MacKeown.)

or the sound gun shot used by the defendant is the same thing. That is one of the things I have got to decide. It may not be the same thing in volume, but do they have the same properties, and are they measured by the same mathematical formulas.

Mr. Graham: Q. Dr. Mackeown, will you please compare the hot wire microphone used in defendant's apparatus with the pressure diaphragm of the Walker patent in suit 2,156,519?

A. The pressure diaphragm in the patent 2,156,519 that is Plaintiff's Exhibit 1, is a metal diaphragm which seals up the end of the tube, and through mechanical linkage and lever system operates a mirror to deflect a beam of light. There [350] is no electrical equipment in the recorder at all. It is purely a mechanical and optical system of recording. The hot wire microphone used by defendant it a device which changes the movement of air past it into changes in the electric current. It does it because the hot wire is cooled by any passage of air by the wire, and this change in resistance causes a change in the electric current flowing through the microphone. The changes are then amplified and they operate a recorder in which the paper is moved under a pen and gives a record of the changes of the air through the microphone.

Now, as Mr. Walker pointed out, the diaphragm disclosed in patent 2,156,519 is able to register both positive and negative pressure impulses. In other words, it can distinguish between a pressure wave and rarefaction. If you put it in front of

(Testimony of Samuel S. MacKeown.)

your mouth and blew on it you would move the diaphragm outwardly and that would result in, say, moving the beam of light to the right and giving you a deflection, let's say, to the right. That would be a positive pressure wave in the diaphragm. If you sucked in the diaphragm then would move inwardly and be deflected in the opposite direction, and the beam of light would move to the left. If we take the wire microphone and blow out on it, that causes a current of air to move through the diaphragm—well, if you blow on it it will be a current of air through the diaphragm which cools it. On cooling this wire, the resistance is decreased and the current will increase. [351]

The Court: Does that have electricity, just the natural electricity in it, or does——

A. From a battery, current is sent through this continuously and that is the thing that raises the temperature of it.

Mr. Graham: Q. There are two terminals on this hot wire microphone and they are connected by wire to a battery, are they not?

A. To a battery.

The Court: In other words, you connect that to electricity and they get red hot?

A. They get a dull red heat, yes. And when you blow on this it cools the wires and lowers their resistance, because as the wires cool the resistance is lowered, which allows the current to increase. If you suck in on this, it also causes a stream of air to pass through these and also cool it. In other

(Testimony of Samuel S. MacKeown.)

words, when any air goes through the microphone, no matter from which direction, it always cools; it never heats the microphone. So that there is no possibility of this microphone having the directional effect that Mr. Walker spoke about, and it responds in exactly the same way to the pressure wave as it does to a rarefaction wave, or it responds the same way to a positive pressure as it does to a negative pressure, and you can not tell from the increase in current whether it has been air going through in one direction or the other direction. [352]

Now, this microphone has, also, another very special feature, and that is that it responds to every change, if those changes are made slowly. If, however, we have rapid changes of the air going through here—if you whistle, then there will be a large number of changes of direction of this air, depending on the pitch at which you whistle. This microphone is not able to follow those rapid changes because there isn't sufficient time for the wire to cool down every time that the current of air changes and comes to rest and goes in the opposite direction. So that this responds only to very low frequencies and, consequently, a great deal of the disturbances, noises and other disturbances at higher frequencies will not be recorded by this hot wire microphone. They cannot give individual swings to your recorder. Furthermore, this microphone is connected to the amplifier through a transformer. This transformer is a very common elec-

(Testimony of Samuel S. MacKeown.)

trical apparatus which prevents very slow changes, changes occurring very slowly, to be effected. So by the use of this microphone and the transformer you have a device which can respond only to relatively low audio frequencies. And, furthermore, it is not affected by very gradual changes, changes of say less than one a second. Very slow changes cannot affect it because they cannot pass through the transformer. This microphone, then, has those differences. In addition, it has to be located in an entirely different position in the apparatus than what is [353] spoken of as a pressure microphone. This is not a pressure microphone.

The Court: You say a very rapid wave, or waves of rapid frequency, I guess you would say, are not recorded? A. Yes.

The Court: What do you mean by rapid? You gave us an instance of very slow, one a second.

A. Yes. Let us say we sound a note——

The Court: Well, take the gun sound from a bullet. Is that a slow——

A. That will have a mixture of frequencies, but the high pitched frequency would not be recorded.

The Court: It has low ones, too?

A. It has low ones.

The Court: Sufficient to affect that and record it? A. Yes.

The Court: Is the result of a hot wire microphone's inability to record or respond to high fre-

(Testimony of Samuel S. MacKeown.)

quencies, does that result in tuning out extraneous sounds?

A. Not tuning out. It does have the effect of not recording the extraneous high frequency sounds, very definitely.

The Court: But that would be the same as if you had an instrument that tuned them out, comparatively?

A. You would not get them. That is the result, you would not get the high frequency sounds. The method is [354] entirely different.

The Court: I understand. But if you did have one that would get the high frequencies, then you would have to tune them out, or can you tune them out?

A. You can tune them out or filter them out.

The Court: If you tune them out or filter them out the result would be the same?

A. Yes, that would have the same result, if you get rid of the high frequency noises. A great deal of the disturbances are kept out and not recorded, because of the inability of the microphone to follow the high frequencies. And you can adjust that by changing the size of wire. If you make your wire of finer material it can change temperature much more rapidly; and by having a very fine wire it will follow the higher frequencies.

The Court: Isn't that very fine?

A. Not nearly as fine as you can get it.

The Court: Really? I can't see it. The result

(Testimony of Samuel S. MacKeown.)

is that when I picked it up I stuck my finger through it. I think I broke the wire.

A. This is not fine wire as compared to the wire in electric light bulbs. Those wires have about 1/10th the size of a human hair. This is not a very fine wire.

The Court: Is that tungsten wire?

A. This is tungsten wire. [355]

The Court: Must it be tungsten wire?

A. No, it doesn't have to be. It must be some wire that will stand dull red heat without oxidizing. It may be nichrome or platinum.

The Court: Silver?

A. Silver would not operate at the temperatures at which this would run. Silver would soften or possibly even melt. But this hot wire microphone does not measure pressure. In other words, if this is put at the end of a tube it will not respond. A pressure microphone is put at the end of the tube and it responds, because at the end of the tube there is pressure, but there is no movement of air. The end of the tube blocks that. This must be put at the open end of the tube or have in back of it some space through which the air can pass.

The Court: In order to respond to the pressure?

A. It doesn't actually respond to pressure. It responds to the movement of air which may be caused by the pressure. It comes under the class of what we call velocity microphones, rather than pressure microphones. A carbon microphone, a crystal microphone, is a pressure microphone. This

(Testimony of Samuel S. MacKeown.)

is one that is called a velocity microphone, because it responds to the velocity of the air through it, rather than the pressure. Those, I think, are the main differences between the hot wire microphone and the——

The Court: But the pressure causes the velocity? [356]

A. The pressure causes the velocity; that is true.

The Court: So calling it a velocity microphone is just diagramming it down a little more?

A. There are a great many actual differences. For instance, this could not operate if it were located in the position shown in patent 2,156,519.

The Court: With the diaphragm?

A. With the diaphragm, because that is closed. You would have to put it at the open end of the tube, because it would be at the open end that you would have a current of air flowing by it.

Mr. Graham: Q. In other words, Doctor, the pressure diaphragm in patent 2,156,519 closes the end of the tube or pipe, which is indicated by the reference numeral 18. A. That is correct.

Q. So that a pressure impulse through this tube 18 impinges against this diaphragm and moves it?

A. That is correct; moves it slightly.

The Court: How much space do you have to have beyond that microphone to get the velocity necessary to cool the wire? Would the thickness of that frame in which it is placed be sufficient?

A. No, you would have to have a relatively large

(Testimony of Samuel S. MacKeown)

volume behind this in order to get enough air passing through there to get any appreciable cooling. In other words, if you have [357] this enclosed in a very small chamber there will be so little air passing through these wires—for instance, if I hold it in my hand, like this, and blow on it, there would not be enough air passing through that to get any appreciable effect.

Q. Wouldn't it depend on the pressure back of it? A. Yes.

Q. If you put a lot of pressure on, it would flow over the wire, and cause it to cool?

A. That would make it very insensitive. It would take a very large pressure to get a very small change. It would be made much more sensitive by having a chamber in back of it, so that the air could pass freely through the wires.

Q. So really it is a matter of degree; that is to say, the greater spread you can have in the space beyond, the more space beyond, the less pressure you would need to apply to get the same result?

A. That is true partially, and only partially, because the amount of air going through not only depends on the pressure, but the resistance that the pressure meets.

Q. I call the witness' attention to defendant's apparatus, and also to Exhibit J, which is a photograph of that apparatus. Will you point out to the court where the hot wire microphone is located, and what I call the bull nose behind it, allowing the passage of air through the microphone.

(Testimony of Samuel S. MacKeown.)

A. The microphone is contained near the union J-5 on [358] Exhibit J, and the red chamber behind it, J-6, is a chamber which allows an opening behind the microphone into which this air can move, and if this microphone were moved down to the end of this chamber it would be so insensitive you would get practically no response. It must be up in front of that chamber so there is some volume in which the gas passing through that can expand. That chamber is what the defendant refers to as the surge chamber.

Q. While this apparatus is before the court, is there anything between the hot wire microphone and the well which operates in any manner upon the echoes coming from the well?

A. No, there is nothing there which operates in any way upon the echoes.

Q. So that everything that comes from the well comes over the microphone?

A. All the disturbances in the well cause air to pass through the microphone.

The Court: What is this little handle down here.

A. That is a butterfly valve, which can be turned in a closed position to protect the microphone on the firing of the shot, if that is desirable, and open to allow the echo to get back from the well. The procedure would be to close that, fire the shot, and open it.

Mr. Graham: Q. Doctor, if that valve is closed, doesn't it destroy entirely the effect of firing the shot, on the [359] microphone?

(Testimony of Samuel S. MacKeown.)

A. No, it is a very loose-fitting valve, with a great deal of space around it so you can get air passing through it, even though it is closed. It is not a tight valve.

The Court: What is this?

A. That is the connection to the hot wire, and also to convey the change in current to the amplifier.

Mr. Mattingly: A complete description of that, your Honor, is in the supplemental answer to interrogatory 14, and the drawings and photographs that are attached to that. That is Exhibit 12-A, B, C, and D., I believe.

Mr. Graham: Doctor, will you compare the electric filter of defendant's Echo-Meter with the tuned accoustical resonator of the Walker patent, 2,156,519, Plaintiff's Exhibit 1, and first describe where the filter is located, and its connection?

A. The filter and its apparatus is located as a part of the amplifier, which may or may not be used.

Actually, what the filter is, is a circuit which is shown better on the schematic of the Echo-Meter electrical filter following page 13 of the manual, and it is incorporated in the amplifier and controls the response of the amplifier by means of preventing the amplifier from giving its maximum amplification, except at certain frequencies.

This adjustment that is made is simply moving certain resistances, and adjusting certain resistances by a very [360] simple manipulation, just the turn-

(Testimony of Samuel S. MacKeown.)

ing of a handle. These resistances are shown in the upper right. The lines with arrows on them indicate variable contacts that can be controlled by moving a handle, and by so doing they, in combination with the condensers which are marked as two lines up on the top, marked 2mu which stands for microfarads, give electrical measure of capacitation. That is the thing that is used to adjust the amplifier. It does not incorporate a resonant or tuned circuit. It is a Wren grid circuit, which gives a balancing effect at certain frequencies, so there is no response at that frequency. This then controls the amplifier and when you get no response to this circuit it allows the amplifier to have its maximum gain. Across this circuit you get a response then that operates at these frequencies to keep the amplifier from having its maximum gain. It is spoken of a as negative feed back amplifier, the negative part coming in to get the response when you don't apply anything to control it. This circuit is a balanced circuit; null in effect. When you get no response in this circuit then you are getting a maximum gain in that amplifier. That is just the opposite way in which a tuned or resonant circuit operates.

A resonant circuit operates to give you a maximum for frequencies which are produced, and this filter operates by balancing not by resonance, but by balancing, like a pair of scales, at a certain frequency. It is an electrical device [361] which has not in any way the properties or characteris-

(Testimony of Samuel S. MacKeown.)

tics of a resonant circuit, in the manner in which operates. Resonant circuits are extremely old. Th theory was first worked out by Lord Kelvin abo 1850. A filter circuit is relatively new, and wa first worked out by Dr. Campbell of the Bell Tel phone Laboratories in 1916. They have been use very extensively by the Bell Telephone Compan and make possible a communication of ten or twent telephone communications over two wires, so tha each party can communicate, and not be heard b the rest. That is entirely done by a filter. They ar entirely different from the resonant or tuned ci cuits, which cannot be operated that way. This an electrical device.

The tuned accoustical resonator as shown in pa ent 2,156,519 is simply a piece of tubing which ha a natural frequency corresponding to the lengt Every organ pipe uses just this. The way you g your notes from an organ pipe is by having a organ pipe of the proper length, so that it wi produce a note, and the pitch of that note is de termined by the length of the organ pipe, and tha is all. The accoustical resonator shown in pate 2,156,519 is just a piece of pipe which will respon to frequencies having a length proportional to th length of that tuned pipe. To change its respon you change the length of that pipe. That is a pur resonance circuit, and it operates on sound wave or pressure waves before they reach the diaphrag or microphone. Any [362] action it has is don prior to that, and it occurs in the gas of the pip

(Testimony of Samuel S. MacKeown.)

The electrical system, of course, cannot in any way affect what happens to the gas prior to its reaching the microphone or diaphragm, and can only operate on currents which are produced by the microphone.

There is another difference which should be pointed out: the adjustment of the tuned accoustical resonator in 2,156,519 patent depends only on the length of the tubing collar, which you wish to emphasize. It does not depend on the nature of the gas in the tubing; in other words, if we have the proper length for a 30-foot tubing that is proper and needs no adjustment no matter what is the pressure of the gas or what the velocity of the sound or pressure on that gas is; it makes no difference. That is always in adjustment because that tubing is filled with the same gas.

The Court: You mean the annular space?

A. The annular space is filled with the same gas that the accoustical resonator is. If you change it, you change the other exactly. You don't have to make any adjustment except for the adjustment of the length of the tubing collars.

Q. The lighter gases rise to the top, don't they?

A. In these wells usually you are having a flow of gas up there, and that keeps the gases pretty well mixed. If the well is not making any gas, then there will be lighter gas in the top than there will be in the bottom. [363]

Q. On the diagram, page 13, which, if any, are the connections with the hot wire microphone ap-

(Testimony of Samuel S. MacKeown.)

paratus? The circuit is through from this box c hot wire microphone to the recorder. Where do that circuit come in?

A. The upper portion of this diagram, with th arrow marked "filter circuit" is the filter circu itself. That is an entity down to the Jones plu The Jones plug then connects from the amplifie and the connections to the amplifier are shown i the lower part of the diagram. The diagram, i the lower portion is not the filter, but the ampl fier, and this is incorporated between the first an last stage of the amplifier, and at the left of th amplifier at the bottom is where the current fro the microphone, after passing through a tran former, enters the amplifier, at the arrow pointin to the left. We were discussing that as a gri circuit. That is connected to the grid of a radi tube. We have shown five radio tubes. That is th symbol for radio tube. There are five radio tub altogether. I will put a circle around the element which are the tubes. Those tubes with the circu connecting them form the amplifier.

The capability of amplifying a certain frequenc is determined by the adjustment of the contacto in the filter.

You have a control, called the volume contro very similar to the volume control on a radio, an that volume control is a manual control of th amount of amplification you get, and [364] th customary operation is that that will be set rela tively low when the shot is fired, and then grad

(Testimony of Samuel S. MacKeown.)

ually increased, so that you increase the amount of amplification you introduce into the system as the wave goes further and further down into the casing, and comes back. Those waves that have to travel any length are much weaker, so you can make up for the weakening effect of the waves traveling a long distance by continually changing and increasing the gain of your amplifier, and you can adjust that gain through an enormous range factor, 100 to 1,000, very easily and very quickly, and it allows the adjustment to the amplifier practically instantaneously for any size of impulse or sound that you are going to receive.

Q. There is nothing new about that?

A. No, it is very old.

Q. You have referred to the term "tuned accoustical resonator" of the Walker patent. Would you please designate whether that is a factor of the Walker patent, so as to tie up with your testimony.

A. The tuned accoustical resonator is a pipe extending from the casing through the coupling 19, and on through to the diaphragm itself. It is the length of that pipe which is actually the accoustical resonator.

Q. And that has its effect on the waves or echoes prior to the time they reach the diaphragm of the Walker apparatus?

A. Yes, it has its whole effect before anything reaches the diaphragm. [365]

Q. This electrical filter and this amplifier you

(Testimony of Samuel S. MacKeown.)

have been referring to are located so that they have effect on electrical impulses after those impulses have been generated or inaugurated by the hot wire microphone? A. That is correct.

Q. So that the operation of the accoustical tuner of Walker and the electrical amplifier and filter of defendant's device are entirely unlike in their mode of operation, is that correct?

A. Yes, they are entirely different in their mode of operation.

By the Court: One is electrical, and one is manual or mechanical?

A. There are a great many more differences than that. It is possible to have an electrical resonator which would be a close imitation of this, and still would be electrical and not accoustical.

Q. I don't mean that judicially. You say that the filter, this thing you have just been describing, operates on a tuned wave length, the electrical filter?

A. No, the electrical filter does not work on a tuned wave length.

Q. The mechanical apparatus 2,156,519 operates on a tuned accoustical resonator? [866]

A. That is correct; it operates on a filter principle.

Q. I thought you said a while ago—I wrote it down—that a filter operates on a tuned wave length.

A. No, I am sure—at least I hope I did not say that. The filter operates actually as a balance.

(Testimony of Samuel S. MacKeown.)

When two impulses are weighed they are found to be the same. That affects the gain of the amplifier in such a way as to allow that frequency to go through. The actual filter circuit is a weighing circuit which balances the effect in the two parts of that circuit, and when they are weighed and found to be the same effect, that regulates the control in the amplifier.

Q. A filter operates on an electrical wave length?

A. Yes, I think you could say a filter operates on an electrical wave length. I want to point out that there is a big difference in resonance and filter. You can have an accoustical resonator and an accoustical filter. They are very different. Mr. Stewart did a lot of work on an accoustical filter which is not a resonator.

Q. You can have an electrical resonating circuit?

A. Yes, and a filter circuit, and they are entirely different.

Q. Then the defendant's apparatus translates the pressure impulse, or the result of the pressure impulse into electrical wave lengths, and records them, whereas the plaintiffs' does not?

A. I would say, rather, electrical frequencies than [367] wave lengths.

Q. Frequencies? A. That is correct.

Mr. Graham: Q. I call your attention again to Exhibit 1, patent 2,156,519. Do we have on our Echo-Meter, defendant's device, a pressure responsive device?

(Testimony of Samuel S. MacKeown.)

A. No, we have no pressure responsive device at all. We have this hot wire microphone, but that is not a pressure responsive device, and does not respond in the way that the pressure responsive device described in that patent is required to. In other words, that patent requires that the pressure responsive device be able to distinguish between a pressure wave and a rarefaction wave, because this patent speaks of the desirability of being able to distinguish these different kinds of impulses. In the Echo-Meter there is no device which is able to distinguish between a rarefaction wave and a pressure wave, and it hasn't any essentially characteristic pressure responsive device.

Q. State whether or not defendant's device has a means for registering the pressure variations produced in a well.

A. No, I don't think it has, because, again, it cannot register the positive and negative pressures, nor the pressure wave as against a rarefaction.

It is incapable of giving this distinctive recognition to a pressure wave and a rarefaction wave. It does measure [368] the flow of air or gas past the microphone that results from pressure variations, but it loses the sense of direction.

The Court: Then I understand you to say that the defendant's apparatus does not record any negative—rarefaction?

A. It records that exactly the same way as it will a pressure. It will record it, but there is no way of distinguishing between that and a pressure

(Testimony of Samuel S. MacKeown.)

wave. You remember, if I blow through it I will cool it; if I suck through it I cool it. And I get the same kind of response on both. Whereas, your pressure responsive device gives me a different one.

The Court: Well, counsel, this question arises by virtue of Exhibit 11-B, the chart. Calling your attention to Plaintiff's Exhibit 11-B; that happens to be a record which was made by an echometer in an oil-well; is that correct?

Mr. Mattingly: That is correct, your Honor.

The Court: I understood from your testimony yesterday that this is the atmospheric pressure of the axis, which should be a straight line, that the positive, or all the pressure waves would record above or to the right of the axis, and the negative or rarefaction waves would record to the lower or left of the axis. A. That is correct.

The Court: On this strip the very first variation in the axis comes to the left, then it crosses the axis to the right. Likewise the second. Likewise the third. Likewise [369] the fourth. And there are only four major variations in the line of that axis, each of which varies first to the left. And, as I understand your testimony and Mr. Walker's testimony, that is the recordation of a rarefaction wave; is that correct?

A. That is correct. May I explain why that is so?

The Court: Yes. That is what I want to know.

A. That is because there are transformers—these things that you were worried about—these trans-

(Testimony of Samuel S. MacKeown.)

formers in the circuit which prevent the base line going through, and all you get are variations, so that you do not know in this method whether the variations are above the line or below it. And if we connected directly in an amplifier to the response and had a current which flowed through the hot wire, these would only be on one side of the line and not on both sides.

The Court: If what?

A. If we measured and recorded directly the current through the microphone, without going through the transformer, then all of these would be on one side of the base line.

The Court: Why does putting them through a transformer record them on both sides?

A. Because the transformer wipes out the position of the base line and you don't know where the base line is.

The Court: So that this does not give us any reading at all of expansion in the annular space?

A. That is correct. For instance, if the pressure in the [370] chamber were increased it would not shift in any way this base line. If you just deliberately pumped in double the amount of gas in there, your base line would still remain the same, although you double your pressure in there, because this change was made so slowly that it would not get through the transformer. The transformer prevents those very slow changes from being recorded.

The Court: Then you cannot tell from this record, or any record made from defendant's appara-

(Testimony of Samuel S. MacKeown.)

tus, for instance, when you have passed through the liner top and entered the perforated casing again?

A. Not from the direction.

The Court: Not from the direction of this?

A. No.

The Court: You can go through something else in here?

A. No. You have no way of distinguishing that, except by position.

Mr. Babcock: It records, does it not?

A. It records the kick, but it doesn't give a different kind of kick.

The Court: But what I mean, you cannot tell from reading this where it is; is that right?

A. You get a kick, and from the position of that kick on the tape, how far it is from where the shot started, you can identify what it is. That is the only method. [371]

The Court: If you can identify that it is a perforated casing you can tell from reading this where it is?

A. That is right; if you know it is a perforated casing.

The Court: If you know in advance?

A. Yes.

The Court: But all you know is that there is something there? A. That is right.

The Court: Or a stoppage in the hole or a cave-in? A. That is right.

Mr. Babcock: Q. I thought you answered the

(Testimony of Samuel S. MacKeown.)

court wrong. The court asked if kicks to the left on that chart indicate rarefactions?

The Court: He said they do not. Now, let me see if I understand you correctly. All this record shows is obstructions. It does not indicate whether they are contractions or expansions in the well?

A. That is correct.

The Court: That would record any rarefaction waves as rarefaction waves——

A. That is correct.

The Court: ——because you have no axis here? In other words, this is an arbitrary line?

A. That is exactly right.

Mr. Graham: Q. Dr. Mackeown, will you state whether [372] or not in the defendant's apparatus there is any means having a natural frequency of oscillation so related to the frequency of the echoes from a tubing coupling as to accent the registration of those echoes?

A. Well, there is nothing in the defendant's apparatus that has a natural frequency of oscillation, at all. The filter circuit does not. And there is nothing that accents the tubing collar reflections in the sense that I understand that is used in the 2,153,519 patent to describe the operations of the accoustical tuning. That is described on page 5, column 1, starting at about line 40. I might read just one sentence, starting at line 48.

"As will be understood, the introduction into a sound wave or multiplicity of sound waves of another wave tuned with one of the waves, produces

(Testimony of Samuel S. MacKeown.)

a beat or amplification of certain of these waves differing in frequency from the first wave will be damped out."

I don't quite understand that sentence myself. I do understand what accoustical tuning is, but there is no such operation in any part of the defendant's apparatus. There are no other waves created and no beats produced.

Q. Will you state whether or not defendant's apparatus has any resonance means associated with receiving and registering means to produce therein a natural accoustical period of oscillation. [373]

A. There is no resonance means at all, and it has no possibility of having any accoustical period of oscillation.

Q. Will you state whether or not defendant's apparatus has any means to accent tubing collar echoes?

A. Well, if "accent" is used to define the operation of the resonance circuit, it does not have that kind of operation. It does have an amplifier in it. The amplifier has a control on it which can be varied, and in that way you can increase or control the amplitude of these echoes that you receive by manually changing that volume control. And in addition it has this filter, but the filter does not accent anything in the sense that—the only thing the filter does is cut down the response. It cuts down all responses, but it cuts down the responses in the region you don't want more than it does the others. But the filter does not amplify. It cuts everything

(Testimony of Samuel S. MacKeown.)

down, but it cuts the unwanted parts down more than the wanted parts.

Q. I direct your attention to patent, 2,209,944, being Plaintiffs' Exhibit No. 3, and ask you to compare the methods of this patent with the methods used by defendant.

A. Well, both the defendant's patent and this patent fundamentally have a method of locating surface levels by using either a pressure impulse, sound wave or sound impulse, and in recording that sound impulse. But in the method disclosed in this patent 2,209,944 the magnitude of the pressure [374] impulse, its characteristics are explained, or the patent states that these must be adjusted so as to bring out the distinguishing characteristics and to get the necessary response.

Q. Where is that in the patent?

A. It is in a number of places. For instance, on page 3, at column 1, starting at line 46, the patent states:

> "The only item which must be provided for is that of producing a pressure wave echo of such magnitude and of such character that the echo from the tubing catcher can be distinguished from the echo received from the fluid surface."

And throughout the patent I can refer to a number of places, there are four or five places where this is emphasized.

This is not necessary in the apparatus used or the

(Testimony of Samuel S. MacKeown.)

method used by the defendant, for several reasons. First of all, it is not possible to get the distinguishing difference on the defendant's apparatus. Then, again, it is not necessary to adjust in any way the character or magnitude of the sound wave or sound impulse that is used, provided only that it is strong enough to get the desired results. If it is stronger, if you increase it, you take care of it immediately by decreasing the gain on your amplifier. If it is weak, you increase the response by changing the gain on your amplifier.

The Court: I don't understand the latter part of your answer. You say it isn't necessary to determine the location of [375] the tubing catcher?

A. It isn't necessary, in any of the methods used by defendant, to adjust in any way the magnitude of the impulse that is introduced into the tube——

The Court: In order to determine where the tubing catcher is?

A. In order to determine anything. You will get the same record.

The Court: You get the same record from a tubing catcher as you do from a tubing joint?

A. Yes, you will get the same record if you use a weak impulse and increase the gain on your amplifier as you will if you use a strong impulse and decrease the gain on your amplifier.

The Court: From the tubing catchers?

A. From everything. You will get exactly the same record all the way down; exactly the same strip; you couldn't tell the [376] difference.

(Testimony of Samuel S. MacKeown.)

The Court: Then you can't tell where the tubing catcher is from your record?

A. Yes, you can tell where the tubing catcher is, because the tubing catcher will give a relatively large kick, compared to the tubing collar echoes.

The Court: I see.

A. But not by the direction of the kick.

The Court: I think I understand.

A. The only thing you want on the record of the Echo-Meter is to have a record of all of the variations which will be large enough to be recognizable and not so big that it will go off the paper. Consequently, you use a shot that will travel down as far as you want it to go and have the echoes come up. You don't have a shot that has any peculiar characteristics or there is no adjustment of the shot or anything of the kind; just one that will be big enough. It may be a big shot. Sometimes a small shot will do.

The Court: Does the length of the pipe ending in the surge chamber and beyond the microphone, does the length of that pipe have anything to do with the working of the apparatus?

A. Well, that pipe is a very short pipe. It is so short that it does not work well for the reflections that come from the well. That is too short. There could be, in back of the microphone, an accoustical resonator, which would improve very [377] decidedly the effect that you would get from using this. In other words, it would be possible to include the accoustical resonator shown in patent 2,156,519, in

(Testimony of Samuel S. MacKeown.)

back of the microphone, either by using a tube, which was some ten feet long, or some such size as that or by using what is known as the Helmholtz resonator. The prior art shows a beautiful example of that. And you could use an accoustical resonator in back of this, but that is not done.

The Court: Does the distance from the hot wire microphone to the end of the surge chamber have any relation to the measurements that are made by this whole apparatus?

A. Yes. If you increase that chamber, you will, in general, increase the sensitivity of this microphone.

The Court: I am not speaking generally now. I have in mind that the plaintiff says a piece of tuning pipe has a definite relation, or will work better, if it has a definite relation to the tubing length.

A. Yes. This would have exactly the same effect as the accoustical resonator would have.

The Court: One-half?

A. One half would be satisfactory.

The Court: That would merely increase the efficiency of the apparatus, or is it necessary to have that for the apparatus to give a definite response?

A. It would do much more than increase the efficiency of the apparatus. It would then, by making use of an [378] accoustical resonator, as shown in patent 2,156,519, give you the selective action of the accoustical resonator if you included the accoustical resonator in the end.

(Testimony of Samuel S. MacKeown.)

The Court: But the one shown here is a commercial apparatus, I take it?

A. That is true.

The Court: But this one that is shown here, the length from the end of this surge chamber to the end of the hot wire microphone, that length has no relation to the tubing length in the well which is used to make it?

A. No. The fact is that that length is such that all it does is emphasize and is resonant to certain disturbances.

The Court: Accents them?

A. Accents them as in the terms used in this patent except it is a resonator for a disturbance which does not want to be measured, a disturbance which would be approximately three or four times this long. In other words, I think we can say the Echo-Meter has deliberately avoided using a tube on the back end of their microphone which in any way could be said to be an accoustical resonator. That could be used in connection with all the rest of their equipment and would give a better response.

The Court: You can have this pipe here beyond the microphone any length?

A. You could have. [379]

The Court: And still get the same results you get now; is that correct? It might be only six inches long or it might be only two feet long, say six inches longer than it is? Would that affect the results obtained now by this apparatus?

A. Yes. The shorter the pipe is or the shorter

(Testimony of Samuel S. MacKeown.)

the volume of that cavity enclosed by the pipe, the lower will be the sensitivity of your microphone, because there isn't the space in back of that microphone for the air to get into it.

The Court: You are speaking scientifically now, and accurately. I am speaking generally from the view point of recording obstructions in the well. Would it still record obstructions in the well if this were six inches shorter or six inches longer?

A. Yes.

The Court: It would record them with approximately the same kind of record?

A. With approximately the same kind of record.

Mr. Mattingly: Your Honor, we have the Depthograph apparatus in court this afternoon. We have it connected up with the gas bottle so that we can demonstrate the manner in which it operates.

The Court: I will come down and look at it. Will you demonstrate it down there?

Mr. Mattingly: This pipe represents the pipe No. 18, shown on patent 2,209,944, and is part of that long tube or pipe that goes in the well, and in actual installation in a [380] well this pipe would be connected through a long pipe to a well casing-head, somewhat similar to that pipe, on the casing-head, which would be some 10 or 15 feet away from the apparatus as it is setting here on the floor.

The Court: I want to see what the pressure impulse does, whether or not it makes a noise.

Mr. Mattingly: That is what we can demonstrate.

(Testimony of Samuel S. MacKeown.)

The Court: How much pressure do you put in there when you shoot a well?

Mr. Walker: The pressure ranges from around 10 pounds up to over 500, depending upon the depth of the well and size of the casing.

The Court: Well, a well 3,000 feet deep?

Mr. Walker: 3,000 feet deep with an 8-5/8 casing, about 100 pounds.

The Court: All right, let's try that.

Mr. Mattingly: That would be a hundred pounds, as compared with the pressure existing in the well.

Mr. Walker: A hundred pounds' difference.

The Court: All right. Let's try it with a hundred pounds first. You have a hundred pounds now. Open that up.

(Illustrating with apparatus.)

The Court: Now, put in 250 and open it up. Is that 250 now?

Mr. Walker: Yes. It is dropping down a little bit; leaking through the valve slightly. [381]

The Court: All right.

(Illustrating with apparatus.)

The Court: What is that gas?

Mr. Walker: Just natural gas. It is harmless.

The Court: All right.

Mr. Walker: Now it is 500 pounds.

The Court: You have got 500 pounds now. All right.

(Illustrating with apparatus.)

Mr. Mattingly: Your Honor, we have here this

(Testimony of Samuel S. MacKeown.)

long piece of pipe which you have been inquiring about. That is fitted to take either the pressure gas from the gas bottle or can be fitted with a gun similar to that of the defendant's device. By that we can compare the relative sounds between the two. On this piece of pipe we have the arrangement to be connected to a gun apparatus corresponding to the type of gun used by the defendant, and it may be interesting to compare the noises of the two pieces.

Mr. Walker: We will not compare noises. We will compare gas volume generated by a shell and gas volume used for testing a well.

The Court: What is this going to be, now?

Mr. Walker: A comparison of the volume of gas directed into a well by a cartridge with the volume of gas which we inject with this equipment.

The Court: Not a comparison of sound? [382]

Mr. Walker: No, that isn't what we are doing here; the cartridge creates such an awful smoke and smell I don't want to discharge it into the room.

The Court: All right.

Mr. Walker: We will first discharge gas into this tube, which is six feet long and two inches inside diameter, and see what pressure it builds up in there. We will take a quantity of gas used in an average well, we will say, 200 pounds in the chamber, then we will take that and discharge the cartridge in there and see where the gauge goes to.

The Court: I see. Can you see where the gauge goes to?

(Testimony of Samuel S. MacKeown.)

Mr. Walker: It is a little difficult to see where the gauge goes to from here.

The Court: Yes. Well, it will be recorded.

Mr. Walker: Now the chamber is filled with 100 pounds, and we discharge it into this 6-inch pipe, and see what the pressure is raised to.

Mr. Smith: The movement is pretty well damped.

Mr. Walker: It is damped by partially closing this valve. What does that read?

Mr. Smith: It reads 35.

Mr. Walker: We will remove the gas chamber and put on the gun and fire a 10-gauge shell into the same tube.

Mr. Mattingly: The piece being attached at the present time is one of the Winchester salute guns, is it not? [383]

Mr. Thomas: A salute gun.

Mr. Mattingly: That is the type of gun referred to in defendant's supplemental answer to interrogatory No. 14?

Mr. Walker: That is right; a 10 gauge cartridge made by the Western Cartridge Company, and a blank cartridge; I believe the same as defendant has in their equipment box in the room. You will have to watch the gauge closely, because the explosion of this powder creates a gas which is heated to a very high temperature as it is generated and the pressure gauge will go up quite high, and as the piece of pipe cools the gas it will cause the gas to contract, and the gauge will drop quite rapidly until it gets down

(Testimony of Samuel S. MacKeown.)

to 25 pounds, where the gas and the tube reach the same temperature.

The Court: Are you ready. What did that register?

Mr. Walker: It registered about 85 pounds. It is a matter of damping of the valve ahead of the gauge. We have damped that in such a way that we are sure that it does not overshoot. It does not indicate any higher pressure than that which is generated.

The Court: What is that yellow thing on the gauge?

Mr. Walker: That is just something to look at, because the damping valve was set so that the pointer reached approximately that point, and keeping the eyes on that position on the gauge you can tell very closely to where it reverses.

The Court: That was about 75.

Mr. Walker: It has been settling back almost stopping [384] at 30, and is practically stationary at 25 pounds, after the gas and the tube reach the same temperature.

The Court: What is stationary?

Mr. Walker: The pointer, the pressure gauge.

The Court: It is stationary at 25?

Mr. Walker: Yes.

The Court: Did you observe that, Doctor?

Dr. MacKeown: I did not notice when it came back.

The Court: He explained that the heat caused it

(Testimony of Samuel S. MacKeown.)

to go up and to come back and to remain stationary at 25.

Dr. MacKeown: I am satisfied with that.

Mr. Walker: The more we fire the more foreign matter accumulates in that valve down there, and it leaks, so it is liable to leak down lower than 25. There is also leakage at this end, past the shell.

The Court: Is there any question about these gauges, their accuracy?

Dr. MacKeown: These two gauges are relatively correct. I am satisfied with it.

The Court: Have you any questions you would like to ask while this equipment is here?

Mr. Graham: Not other than I might ask you—you do not claim that your patents in suit cover the mere firing of a shell or the introduction of a pressure wave from this cylinder in the well, do you?

[385]

Mr. Mattingly: Not that alone.

The Court: Is there any ratio of increase in the pressure, say in your 6 feet of pipe with the pressure of gas released into the pipe; in other words, 150 pounds produced 35 pounds on the gauge. Suppose you put 500 pounds in there, would that be approximately three times that?

Mr. Walker: Approximately, your Honor; approximately three times.

Mr. Graham: Q. Dr. Mackeown, are you familiar with the method of measuring sub-surface pressure, using the method employed in figure 2 in

(Testimony of Samuel S. MacKeown.)

front of page 52 of the manual defendant's exhibit 11-C?

A. Yes, I am familiar with the method shown in that figure.

Q. Does the method illustrated on that Figure 2 of Exhibit 11-C require a knowledge of density?

A. No, it is not necessary to know or determine the density of the fluid in the annular space to calculate the sub-surface pressure by this method.

Q. Will you please explain the method illustrated there on Figure 2.

A. This method is based on taking measurements of the fluid level at two different levels when the production rate is maintained constant, reading the casing head pressure, and from these readings, calculating the casing head pressure, which would be necessary to depress the fluid in the annular [386] space down to the desired surface at which you wish the pressure; that probably would be the pump. By this method of calculating the casing head pressure which is required to actually move all of the fluid down to the level of the pump, and out of the casing. Then the height of the fluid level, under those conditions, is zero so that the density of the fluid is not determined, or does not enter into the calculation.

You have a condition then, where you have depressed or calculated casinghead pressure necessary to depress the fluid right down to the pump, so the height in your fluid column is zero, and you do not take into account or use the density; you simply take that casing head pressure and add to it the

(Testimony of Samuel S. MacKeown.)

weight or the pressure exerted by the column of gas in the annular space and that gives you the pressure at the surface.

If we refer to the formula on page 35 of the manual, which has been used before, spoken of, which reads—this is marked formula 1 on page 35 of the manual, which reads: "that the bottom hole pressure is equal to the pressure at the casinghead plus pressure of the gas, plus the height of the fluid column, times its density"—that formula is correct, but, in this case, you see, our height was zero, so the last term does not add anything, and we don't have to know what the density is. You apply the same formula, you have calculated the condition where your fluid level is zero. You don't have to know the density. [387]

Q. You have referred in this manual to finding two fluid levels. Does that method include the determination of pressure on fluid surface at those two levels?

A. No, it does not. This method includes only the determination of the pressure at the casinghead, which is read on the gauge. The pressure on the fluid surface in those two cases would not be casinghead pressure, but would be that casinghead pressure plus the pressure exerted by the column of gas. In this method you do not calculate the pressure on the surface, but only the pressure existing at the top of the column of gas, where the weight of the column of gas does not enter in. And the weight of the

(Testimony of Samuel S. MacKeown.)

column of gas above either one of those two fluid levels is not taken into consideration.

The Court: You mean you do not add that at all?

A. You add that at the bottom, but you do not add at the level at which you make the measurements.

Q. That is taken into consideration?

A. No, your Honor, it is not. This is based on the theory that the liquid column will be depressed the same amount as you increase the pressure at your casinghead. If I increase my pressure at my casinghead by 100 pounds and thereby depress the fluid level 50 feet, this is based on the theory that for every 100 pounds of increase in pressure it will decrease it 50 feet. It does not take into account the pressure at the fluid level, but the pressure at the casinghead; and then when you [388] come to calculate the casinghead pressure sufficient to depress the liquid to the bottom you have to add a correction for the pressure exerted by the gas the whole length of the column to give you the actual existing pressure at the bottom of the hole or the pump.

Q. Would you take the pressure of the fluid at that level?

A. We would take the pressure of the fluid at that level if you ever had that level there.

Q. And if there was any fluid.

A. And if there was any fluid.

Q. How does that give you the pressure? You have got your formula here? A. Yes.

(Testimony of Samuel S. MacKeown.)

Q. That proves it to you who know something about it; how does it prove it to me?

A. We apply the same formula. The pressure at the bottom of the hole is made up of three parts. One part, the casinghead pressure, which is used on the gauge at the top. That might be 300 pounds. That is the gas pressure at the top of the hole, where the gauge is.

Q. Isn't that pressure all the same all the way down?

A. No; because as you go down in the hole you have in the gas column the weight of the gas.

Q. I mean excluding the weight of the gas. The casing- [389] head gas pressure is the same in the annular space all the way down, isn't it?

A. The casinghead pressure is only the pressure at the head of the casing. Then as you go down in the casing, the pressure increases all the way down only by the weight of the gas.

Q. Then excluding the weight of the gas, the pressure in this annular space is the same from the top of the well, or the casinghead, to the top of the fluid?

A. That is correct.

Q. Then you add the weight of the gas?

A. Yes.

Q. So that your casinghead pressure, if it is 300 pounds, eliminating the weight of the gas would be 300 pounds on the fluid level?

A. That is correct. To answer your question, in this formula, since you have calculated the casing-head pressure when your height is zero, to find the

(Testimony of Samuel S. MacKeown.)

actual pressure existing, you take and calculate the casinghead pressure to give you zero height, and add to that the column of gas.

Q. That is Pg?

A. That is Pg. That is the weight, the pressure due to the column of gas.

Q. Then it would be identically the same if you took the pressure on the fluid level and added the weight of the [390] column of gas, wouldn't it?

A. The pressure on the fluid level has the weight of the column of gas included in it.

Q. What I am trying to understand; you expressed right here a casinghead pressure?

A. Yes.

Q. The plaintiffs have been talking about pressure on the fluid surface? A. That is correct.

Q. You are talking about the same thing?

A. No, we are not.

Q. It is the identical factor?

A. No; the pressure in Los Angeles is different than the pressure at Mount Wilson. The barometric pressure, the ordinary pressure in your gas, is lower at Mount Wilson because Mount Wilson is higher. On top of Los Angeles there is a column of ordinary air extending 5000 feet up in the air, which is not present at Mount Wilson, so our pressure here is greater. The pressure at the fluid level is the same as the pressure at the casinghead plus the column of gas.

Q. How do you tell what the pressure is at the bottom of the hole?

(Testimony of Samuel S. MacKeown.)

A. The pressure at the bottom of the hole is the pressure required at the casinghead to depress the liquid to the bottom of the hole plus the pressure of the gas column at the bottom of the hole. [391]

Q. That is something that you know?

A, That you can calculate; plus zero for the last term, because the height of your fluid column is zero.

Q. I think I understand it now. In other words, the pressure at the bottom of the hole is the amount of pressure which is exerted by the introduction of whatever you use to increase the pressure at the casing head, which likewise increases the pressure on the surface level the identical amount?

A. Yes.

Q. And so many pounds per lineal feet of the weight of the gas?

A. Yes. It is not quite uniform, your increase in your gas column. It is not proportional to the depth. In other words, the first 100 feet of gas do not add the same amount of weight as the second 100 feet; the second 100 feet add a greater increase.

Q. On this chart at 3980 feet the casinghead pressure is 18 pounds per square inch?

A. Yes. That is in a stable pumping condition.

Q. In other words, that is without any increase or decrease, just as the well is pumping?

A. Yes.

Q. Then you add 100 pressure to increase to 130 pounds? A. That is correct. [392]

Q. Then you measure the fluid?

(Testimony of Samuel S. MacKeown.)

A. That is correct.

The Court: Then, that is the last measurement you take?

A. That is the last measurement that you take.

The Court: So that you extrapolate those figures to the additional place where the pump is located——

A. That is right.

The Court: ——by measurement of a known factor, and you get the pressure at the pump at 4890 feet; is that right?

A. That is an extra measurement that has been made in this case.

The Court: You wouldn't need to do that?

A. You wouldn't need to do that. The other two points would determine the straight line.

The Court: Down here you have got "Casinghead pressure 258 pounds. Gas column 42 pounds".

A. The bottom of the well is at 5125 feet, and if you read from the curve, the casinghead pressure which would be necessary to depress the fluid to that is 258 pounds. You see, at the bottom of the scale in the abscissa, is between 200 and 300. So you can read from that scale that intersects with that line at 5125, which would be 258 pounds. That gives you the casinghead pressure necessary to depress the liquid to the pump level. Then to find the true pressure you add the weight or the pressure exerted by the gas column all the way down, which calculates out to be 42 pounds. [393]

The Court: I think I understand the formula.

(Testimony of Samuel S. MacKeown.)

Mr. Graham: Q. Now, Dr. Mackeown, will you take the Batcheller patent 602,422, that is defendant's exhibit O-2, and compare it with the patent, 2,156,519 in suit?

A. This apparatus is best shown in Fig. 3 of the Batcheller patent. The purpose of the Batcheller patent is to find obstructions in tubes, primarily pneumatic tubes, such as are used for carrying mail and packages. Unknown obstructions. You don't know where they are and want to locate them. And that is accomplished by firing a revolver, a blank cartridge, from a revolver which is shown at K, into the tube; and the sound impulse hits the obstruction, is reflected back, and then travels through the tube H^{12}, through the valve H^{13} to the mechanical recorder which is shown as H^{11}, where it makes a mark on a smoked piece of paper. The diaphragm and its mechanical linkage is shown enlarged in Fig. 4. The diaphragm is shown as H^6 and it operates a lever mechanism which is marked H, ending in a stylus which is h, and that small stylus makes a mark on the paper. They way it makes this mark is shown in Fig. 1.

In Fig. 1 is shown the way this stylus is actuated by this pressure diaphragm, making a record. It is shown in the lower left of that picture. To the right of that is a [394] timing device actuated by a clock mechanism, which is shown in Fig. 3 as G^8, a pendulum which swings, and every time the pendulum reaches its lowest point it closes a contact and that moves a stylus G^4 and, in addition, a

(Testimony of Samuel S. MacKeown.)

timing record is made by the tuning fork F. So we get a resultant record shown in Fig. 5, where the marks n^1 and n^2 are caused by the stylus *h* on the pressure diaphragm. The mark n^1 marks the time at which the gun was fired, and the mark n^2 is the record from the echo from the unknown obstruction. The mark on the right of that marked L is caused by the clock or pendulum, and indicates time in half-second intervals. The curve in the center is traced by the tuning fork, which is set to be operated, for instance, at 512 cycles. That is the frequency of "C", high-C, in the audible range.

Q. State whether or not this patent, at the time of this invention of Batcheller, recognized the fact that the rest of it was old, that is, as far as the shot and making an echo, and return of the echo and receiving it against the diaphragm?

A. Yes. It states so in that paragraph starting at line 17, page 1. You asked me to compare this with patent 2,156,519. This uses the same type of mechanical recorder that is used in the apparatus of the patent 2,156,519. There is no microphone or electrical equipment employed, but a [395] pressure diaphragm which operates through a mechanical leverage system to produce directly the record. Of course, the apparatus in patent 2,156,519 will use a light beam and photographic strip instead of the smoked paper.

This apparatus uses the firing of a blank cartridge to produce the sound impulse, which is different from the type of impulse employed in the

(Testimony of Samuel S. MacKeown.)

patent 2,156,519. There the impulse is produced from a gas chamber. The type shown in the Batcheller patent, where a blank cartridge is fired, is the type of sound impulse employed in the defendant's apparatus.

Mr. Graham: Q. Now, Doctor, will you take the Fessenden patent 1,240,328, Defendant's Exhibit O-4, and compare that with the 2,156,519 patent in suit?

A. This Fessenden patent is important only because it shows the use of sound waves and the reflection of sound waves for measuring the distance to an unknown object without having to know the velocity of the sound waves or measuring the time, or lapse of time for those sound waves to travel their path. It is done simply by comparing the distance, and no measurement of velocity of sound waves or lapse of time is necessary. The arrangement that Fessenden uses as shown in Fig. 1, in the lower right-hand corner, is a shallow drill hole, and in each corner is a drill hole which is filled in with water.

The Court: Which is the drill hole? [396]

A. The drill holes are 11, and are shown in Fig. 2 in perspective. The drill hole in Fig. 11 in the lower right hand corner, 14 in the upper right-hand corner.

Q. In other words, in Figure 1 you are looking down on that just the same as a circle, and in Figure 2 that is as though you cut it down through the ground and saw the actual hole in the ground?

(Testimony of Samuel S. MacKeown.)

A. These drill holes are laid out at a known distance which, in the patent, is said to be five miles, and a source of sound is introduced in one of these, and is shown introduced into the drill hole 11 by means of a generator or oscillator which is actuated by the key 41. Now, if this sound is produced in the hole 11 it travels in a straight line to each one of the receivers, and makes its mark.

Q. That is, it travels through the wires on the surface?

A. The electrical impulse travels through wires and makes it mark, and in addition the sound travels to the receiver and makes a later mark on that, because sound travels relatively slowly.

Q. Through the earth?

A. Through the earth. It is indicated as traveling through the line 59, along the path 59 to the receiver 18, and that makes another mark on that recorder which can be used to represent the distance on the record required for this sound to travel the known distance on the record required for this sound to [397] travel the known distance between those two which, say, is five miles.

Q. It has first been recorded at 15 in the hole 11? A. Yes.

Q. Does there have to be water in this hole?

A. There has to be some means of transmitting this sound wave effectively from the sender to the ground. This is a travel through the ground. In addition another sound wave may go out and hit such a body, as an ore body, as the body 44, and

(Testimony of Samuel S. MacKeown.)

that will be reflected up to the receiver 18 in hole 14, and also reflected back to the receiver in the hole 18 where the sound originates. The receiver is 15 in the hole 11, where the sound originated. By recording the arrival of the sound Fessenden can locate the distance of this body 44 from two holes, and thus find its location in space, in the ground. He compares the time of return of 15 with the time to 18, and the time along 59.

The only point I think in this patent is that this is a method of using sound in a medium of which the velocity of sound is not known; that is, in the ground, to measure distance without the necessity of measuring time or knowing the velocity.

Mr. Graham: Q. How does that last statement of yours compare with the defendant's method?

A. The defendant uses that method, because it measures the distance of either lengths of tubing, or the distance to [398] some obstacle, such as tubing catchers, and from that distance or record, it uses that to calibrate in terms of distance, and can directly determine the distance to the fluid surface without the necessity of measuring the velocity of the sound in the gas or the elapse of time in that gas. It is not necessary to do that. You can follow this method of Fessenden, in which you simply calibrate your instrument in terms of a known distance.

Q. I will ask you, Doctor, to discuss the Tucker patent, 1,351,356, entered as Defendant's Exhibit O-5, with patent 2,156,519.

(Testimony of Samuel S. MacKeown.)

A. This Tucker patent, which is Exhibit O-5, is a description of the hot wire microphone used in the defendant's apparatus. It is also a description of a tuned accoustical resonator used in combination with that microphone to give the characteristic resonance response that you get from the resonance action, and to make the microphone, when so used, particularly responsive to certain frequencies.

The microphone itself is shown in Fig. 4, where you see the fine wires used in the hot wire microphone, and the wires are marked *m*, and air passing through these wires which are heated cools them and allows the current to increase, and it is this variation of current which is amplified and recorded. This microphone was developed for locating gunfire, and in the article by Tucker, which will be referred to, it shows [399] that he was a Major in the British Army, and used this for locating gunfire.

I mean by that a distance away from the observer, that a gun was fired. That can be done by using several of these and using the ordinary method of triangulation, knowing when the sound arrived at two or more stations, the gun being at an unknown point. The patent states, and I am starting at line 11 on page 1:

"This invention relates to an improved thermic sound detecting device intended more particularly for determining the position or the origin of a sound produced by the discharge of a gun, although the

(Testimony of Samuel S. MacKeown.)

use of the improved sound detecting device is not limited to such determination or origin, the invention being applicable also to the detection and measurement of such sounds and also to sounds emanating from other origins than from a gun, and being generally useful also, for other purpose, such as the measurement of velocity and consequently of the quantity of gases or liquids flowing through tubes or pipes."

This device is not only sensitive to that kind of a sound, that is, a report from a gun, but it is relatively insensitive to ordinary noises. That is because the wire cannot cool off sufficiently between the pressure and rarefaction wave to record the higher frequencies present in most sounds. [400]

The Court: What does he invent: the sound detecting device; I mean a microphone?

A. He has invented primarily the combination of this microphone, using it with an accoustical tuning resonator for any purpose it wants to be applied.

The Court: The microphone existed before; is that right? a combination of the microphone——

A: I don't know whether the microphone was used in this form prior to this time or not. It may have been. I believe all the claims, without having studied the claims, are limited to the use of the microphone with an accoustical resonator or a sound box.

The Court: The tuned accoustical resonator is a sound box?

(Testimony of Samuel S. MacKeown.)

A. In this case where the sound box is tuned it is a special resonator, because of the construction of it. The sound box on a violin or on a piano is not tuned, because its function is to reproduce clearly all the sound from the violin. On line 55, at the bottom of column 1, page 1, the patent states:

"the sensitiveness of the sound detecting device is constant, and the same does not respond to ordinary noises nor is it affected by vibration, and it assumes its normal condition immediately after each vibration.

On the bottom of this page he states that this microphone can be connected to an Einthoven string galvanometer, which is an oscillograph, to make permanent records of sound waves. [401] That is in the paragraph starting at line 99.

Tucker, in this patent, not only describes this microphone, but describes it in combination with different tuning accoustic resonators. That is shown best in Fig. 2. The microphone is at the right of this box, at the throat, and it is mounted with the terminals *i j*, which are means of forming the necessary electrical connection to the battery supplying the microphone current, and, also to the transformer or amplifier which will amplify the changes in the current existing there. The box indicated by *b* is a box, the volume of which can be changed, because the one side can be slided over the other, accordion style.

(Testimony of Samuel S. MacKeown.)

The Court: Is that box what you call a tuned accoustical resonator?

A. That in combination with the throat. That is *h*.

The Court: Where it goes into the opening of that *l*, little *l*?

A. That is little *l*. If we take a box and have an opening in it, and have connected to that opening a throat, then that box is an accoustic resonator, a so-called Helmholtz resonator, because Helmholtz was the first one to see that this is a resonator. And the frequency to which it will respond depends on the volume of the box.

The Court: And the cross section? [402]

A. The length of the throat. You can, therefore, change the frequency to which this will respond either by changing the volume of the box or the length or cross section of the tube forming the throat.

The Court: Take the whole side out here?

A. You see, we change the length of the box——

The Court: If you change it you take the whole side out?

A. No. The throat is the small opening indicated by the letter *h*.

The Court: The opening into the box is *l* isn't it?

A. Yes; but if we do not have a throat we will not have a good accoustic resonator.

The Court: I see. That is really the tuning device, when the box is set.

(Testimony of Samuel S. MacKeown.)

A. You can tune it by changing the throat or by changing the volume of the box.

The Court: If your throat is of a set length the tuning is accomplished by changing the size of the box?

A. That is correct; and that is shown in Fig. 2, how you can tune it by sliding the box and changing its volume.

The Court: All right.

A. On page 2, starting at line 116, that is described:

"The box *b* on which the sound detecting device hereinbefore described is attached, may be formed of two parts which are mounted telescopically, as shown in Figs. 1 and 2, in [403] order to vary the capacity of the box and thereby obtain a resonant effect."

On page 3, starting at line 12:

"According to a further feature of the present invention, use is made of a plurality of sound detecting devices, and more particularly of thermic sound detecting devices, each of which is combined with an accoustic resonator of a particular pitch in such a manner that a series of combined sound detecting device and accoustic resonators are obtained, the pitch of which extends along the whole range of accoustic vibrations, or along a portion of such range, according to the object in view."

Such a system is shown in Fig. 25 on the last sheet of the drawings in which there are four of these accoustical resonators, marked M^1, M^2, M^3 and M^4. Each one is adjusted for a different

(Testimony of Samuel S. MacKeown.)

frequency, because their length is different; and the hot wire microphone at the throat of each one of these, connected to wires up to the terminals of the switch S^2 can be used to connect any one of these four to the amplifier, which is marked A and so described.

I think the only important part of that is having the microphone connected through an amplifier to a recorder. This shows, then, a hot wire microphone in this case in an accoustical resonator connected through the amplifier, which is A, to a recorder, so that you get an amplified record of the microphone actually recorded. [404]

The Court: Is that what was new about this?

A. That is one of the applications of the Tucker patent. I think what is actually new in the Tucker patent is the use of this hot wire microphone in combination with the resonating chamber.

Mr. Graham: Q. Doctor Mackeown, will you take the Wyatt and Lehr patent No. 2,047,974, which is Plaintiffs' Exhibit No. 18, and compare that with patents 2,156,519 and 2,209,944 in suit?

A. This patent discloses apparatus and methods for determining the surface level of a fluid by means of using a pressure impulse, and recording the time necessary for that pressure impulse to travel down the casing to the fluid surface and return. This patent points out the difference between the use of a pressure impulse and the use of sound wave methods. In the paragraph starting

(Testimony of Samuel S. MacKeown.)

at line 10 of the first column, page 1, it says that the sound method is old, and it operates more perfectly in theory than in practice and then, in the last sentence of the next paragraph, starting at line 38, it says:

"The present method and apparatus affords means for determining well depths without the use of a sand line, and saving considerable labor; and without the use of a 'sound method' which is more or less unreliable."

In the second column, starting at line 29, the patent says:

"Before proceeding to a detail description of this [405] invention, it should be stated that it employs the impulse wave principle, and the impulse wave is not generated by sound, but is generated by causing a sudden change in pressure at the well head. This change in pressure may be occasioned by a sudden liberation of a sufficient quantity of gas at the well mouth to cause a sudden substantial increase of pressure or a sudden decrease of static pressure within the well head, and it may be accomplished so that only a slight change in pressure at the local point results."

There are two methods of determining the time required for this impulse to travel down the well and back. The one shown in Fig. 1, is one in which there is a small outlet pipe from the casing marked 9, on Fig. 1, and the patent states that the observer can use a stop watch and record the interval of time between the opening of the valve 6,

(Testimony of Samuel S. MacKeown.)

the quick opening valve 6, which initiates the impulse, and the time that he feels a puff of air from the outlet. In Fig. 2 is shown another method, where the outlet marked 13, Fig. 2, is connected to a microphone marked 15, which goes up to an amplifier which is marked 18, and then to a recorder, so that a permanent record can be made of the impulse, as it enters the casing from the impulse chamber, and also as it returns from any obstructions in the well. This method is described on page 2, starting at line 10 in the second column, where it states: [406]

"If it is desired to have the result of the test indicated or recorded, this can be accomplished by providing a small pipe connection 13 (see figure 2) which is attached to the casing 14 instead of the outlet 9, and this connection may carry a microphone 15 which is electrically connected with an indicating or recording instrument 16. If desired, the third connection 17 between the microphone and the indicator 16 may include an amplifier 18 connected to conductors 19 and 20 of an electric power circuit.

"The recorder 16 may be provided with a pen arm 21 which would be controlled by an impulse in the circuit 17 and this pen arm would carry a pen or pencil 22 to run on the face of a recording drum 23 mounted to rotate on a horizontal axis in bearings 24."

(Testimony of Samuel S. MacKeown.)

That is similar to the type of recorder used in the Echo-Meter, with the exception that in the Echo-Meter recorder the pen remains stationary and the paper is moved underneath it.

In the method of this patent, after determining the time required for the wave to come back, Wyatt and Lehr provide a formula which is a well known formula for calculating the velocity of the impulse wave in the gas. That formula takes into account the nature of the gas, and is a correct formula, which has been known for a long time, and if you take a sample of gas and determine its density and other characteristics, then you can apply this formula and calculate the velocity. [407] The velocity would not be, of course, the velocity of sound in air unless the gas in the casing happens to be air, but this formula will give you the correct value for the velocity. The method of initiating the impulse in the Wyatt and Lehr patent Plaintiffs' Exhibit 18, and the method of initiating the impulse in 2,156,519 patent are identical. Both of them use an impulse chamber with a quick-opening valve.

In the Wyatt and Lehr patent a permanent record can be made with the apparatus shown in Fig. 2. That permanent record is made by using a microphone and amplifier and a pen recorder. That is a different method of recording than is used in the 2,156,519 patent, where a pressure diaphragm is used, and that pressure diaphragm actuates a small mirror, and the recording is done

(Testimony of Samuel S. MacKeown.)

photographically by light reflected from this small mirror actuated by a pressure diaphragm.

The time is measured in this Wyatt and Lehr patent and the distance is determined by using the calculated velocity of the gas in the well. If you know the time between the initiation of the impulse and the return of your velocity, then you can calculate the distance to the surface level. That is one of the methods used in patent 2,209,944 for determining the distance to the surface level.

The Court: What did Wyatt and Lehr invent?

A. They actually invented the impulse chamber as a source of pressure impusle. [408]

The Court: That is the only thing new about their patent?

A. Each one of the claims I think has as a limitation. You cannot infringe any of those claims unless you use that impulse chamber.

Mr. Graham: Dr. Mackeown, will you please take the Scott patent, No. 1,173,426, Defendant's Exhibit O-13, and consider the recorder system, the electrical system in that, with the recorder system in 2,156,519, the patent in suit?

A. This Scott patent describes an electrical system of amplifying and adjusting an amplifier so it is selective to certain frequency bands, and there is no such system in the 2,156,519 patent. It does not use any electrical means of recording or amplifying. This amplifier, with the filter circuit, is the type of circuit that is used in the defendant's apparatus.

(Testimony of Samuel S. MacKeown.)

The Court: To express the behavior of the Scott circuit in its simplest possible terms, as I understand it, the sound is first amplified, then it is reduced by taking certain sounds out of it, assuming it were sounds?

A. Yes. And where it is reduced, when you get a low voltage in that circuit, allows a maximum gain in your amplifier, to the things you want to amplify. There is no tuned or resonant circuit in this.

Mr. Graham: Q. Doctor, will you take the Halliburton patent, No. 2,201,311, Exhibit O-4, and discuss that patent [409] in connection with the patents, in suit, or the defendant's system?

A. This patent describes a method of locating the position of a plug in a casing, the plug being used for cementing purposes, and it is desirable to know how far down in the casing this plug has been forced, and this is done by mounting on the cementing plug two arms on springs, which, when they pass a casing joint, will move outward and hit the casing core and give a noice; that noise then travels up through the casing. The casing carries the noise sound very well. It is then recorded by a microphone at the top of the casing. The response goes through a filter and an amplifier, and gives a record of the number of casing collars that have been passed. Fig. 1 shows the cementing plug down the well, with the arms on it, just before the arms come to a casing collar. As they pass this casing collar they will spring outwardly and hit the casing collar,

(Testimony of Samuel S. MacKeown.)

and give a noise, which will travel upward through the casing to a microphone, which is shown in Fig. 5. This microphone is clamped against the casing and the sound is conveyed from the casing to the microphone by metallic contact. The microphone, which is shown schematically in Fig. 8, then goes to the filter, which is marked 41.

A. The microphone is shown by 22, and the microphone consists of a diaphragm, which is in contact with the metal [410] pipe, and this is an iron plate and as it moves back and forth, and changes its position relative to the core, which is 22, that changes the current in the winding 40, and that current then goes through the filter, which is 41, through the amplifier 42, to the recorder, which is a magnetic recorder; that is, it is operated by the magnet 43; and that magnet pulls upward on the armature 44, and causes the stylus 46 to move downwardly and make a record each time a casing collar is encountered. The record that is obtained is shown in Fig. 6. Each time a casing collar is encountered you get a mark, due to the sound which travels up through the casing, which is picked up by the microphone, goes through the filter and amplifier, and operates this recorder.

The description in this which we are interested in is on page 2, starting line 16 of the first column, and then on line 55 of the first column and line 67. The paragraph starting line 67 describes the use of the filter, and I might read a sentence or two of that.

(Testimony of Samuel S. MacKeown.)

"Now it is known that electrical impulses of comparatively low frequencies, such, for example, as the frequencies which correspond to audible sound, can be filtered to remove all impulses or other frequencies. If, therefore, a suitable filter is provided within the recording apparatus 25, as shown at 41, the recording instrument therein will receive [411] only the impulses caused by the knockers 16 and 17 striking the casing. It is preferable also to provide some electrical amplifying circuit within the recorder 25, and this is shown at 42 in Fig. 8."

Then it goes on to describe the recorder.

The Court: By a suitable filter he means a filter known to the prior art?

A. The filter design is something that has been known since 1916, and has been extensively worked on, and the design of that is well known, primarily from the telephone company; the Bell Telephone Laboratories have done the major work on that.

Mr. Graham: Q. Did you compare that detecting recording circuit in this Halliburton patent with the detecting recording circuit which is used in the defendant's devices in this suit?

A. Both of the recording circuits, that is, the one shown in the Halliburton patent, and that used in the defendant's apparatus, make use of a microphone for changing the sound impulses into electrical impulses, and, then, all of them include an amplifier, and the apparatus in the defendant's apparatus includes inside the amplifier a filter which may at times be used. The filter is used differ-

(Testimony of Samuel S. MacKeown.)

ently slightly than as shown in the Halliburton patent, and is used in the method shown in the Scott patent, but both of those use a microphone, a filter and an amplifier, and from that amplifier a recorder, which mechanically gives you the marks showing [412] in one case the casing collars and in the other case, the Echo-Meter, the tubing collars.

Q. Dr. Mackeown, with respect to the reissue patent in suit, I will call your attention to certain publications that have been offered in evidence, and ask you to compare those publications with the disclosures of the reissue patent. The first one is the article by Wilde and Moore: A Method for Determining Production Allowances in Prorated Fields, which is Defendant's Exhibit K-1.

A. This article by Wilde and Moore is on a method for prorating oil wells based on both the acreage and the capacity of the individual well to produce, and in this article Wilde and Moore show how you can obtain the capacity of the well, the productivity index, or the maximum production capacities, by taking bottom hole pressures at different rates of production and plotting them to obtain a curve, and from that curve determining either the productivity index or the maximum capacity in the well, which then can be taken in as a factor in prorating the different wells.

On page 72, starting in the second column, under the title "Bottom Hole Pressure Relationships" are several paragraphs which describe the condition at the bottom of a well, and where the production can

(Testimony of Samuel S. MacKeown.)

be obtained from this type of curve. The curve is shown in Fig. 1, and of the whole of this paper, I think the only part that is pertinent is that [413] portion under this heading "Bottom Hole Pressure Relationship" because that describes this method of determining the production of the well from measurements of the bottom hole pressures. This is the same type of curve as is shown in Figs. 4 and 5 of the reissue patent. In both of these curves you have plotted on your abscissa the production rates in barrels per day, and as the ordinate the bottom hole pressure, and in the curves, in the reissue patent the ordinate is marked pounds per square inch at the pump, but that I think is essentially the same thing.

That would be, if the pump was at the inlet to the well, the inlet from the sands. That is where you want your pressure to be zero to get your maximum capacity; not actually physically at the bottom of the well, nor at the location of the pump, but actually at the inlet from the oil sands to the well. When the pressure is reduced to zero, then you are getting the maximum amount of oil flowing into the well that is possible from the sand. I think there is no need of reading this portion of this article. It is a recognition of this method of using bottom hole pressures for determining the production of a well.

Q. That article is dated June 30, 1931. You referred to that chart on page 72 as being like this shown in the reissue patent, is that correct?

(Testimony of Samuel S. MacKeown.)

A. That is correct. This does not show a straight line. [414] It may be that in the well in which these curves were taken it is not a straight line relationship, but there are sufficient points there so that you can determine from that the place where the pressure will be reduced to zero at the bottom of the well and the maximum potential capacity of the well.

Q. Will you take the Hawthorn article entitled "Sub-surface Pressures in Oil Wells and their Field of Application", Defendant's Exhibit K-3, and compare that with the disclosures in the reissue patent in suit?

A. This is a rather long article, but I think we can limit our discussion to one particular case that Hawthorn talks about and as to which he shows the results in Fig. 1, which is on page 153. This article by Hawthorn is a general discussion of methods of obtaining subsurface pressures in oil wells, and their use, and he goes into a definition of the terms, and how the subsurface pressure can be calculated in certain cases. The particular case exemplified in Fig. 1 on page 153 is described on page 152, and I will read the first paragraph so we will understand what is plotted there, and what the meaning of these curves are, under the title "Subsurface Tests":

"Subsurface pressure tests in general may be divided into two classes, namely static tests and flowing tests. In either case pressure may be obtained

(Testimony of Samuel S. MacKeown.)

at any point within the [415] flow column to which a pressure bomb can be lowered, thus giving information from which curves or pressure gradients can be plotted; see Fig. 1, where curve 1 is the static pressure gradient, curve 2 is the flowing pressure gradient and curve 3 is obtained by plotting bottom-hole pressure against rate of production of the well during the test.

"This constitutes all the information in regard to pressure that is directly obtained in making a subsurface test. If desired, the bottom-hole temperature may be easily obtained by attaching a maximum indicating thermometer to the bomb."

Referring to Fig. 1 on page 153, we have three curves on that. Curve I is a plot between the pressure in pounds per square inch, plotted on the ordinate, and the well depth in feet plotted on the abscissa. That is the middle curve. That curve is a straight line from the bottom of the hole, which is at some 3700 feet to a point about 750 feet, and that straight line is the drop occurring in the fluid column. This is a static curve, which was taken when the well was shut in. From 750 feet approximately to the top of the well is the increase of pressure, the small increase in pressure, due to the gas column.

Q. And that is marked 1 on the curve?

A. That is marked 1 on the curve, and the gas column and the intersection of those two curves is marked as the [416] fluid level encountered at 725 feet. To the left of this curve is a calculation of the specific gravity or density of the pressure gra-

(Testimony of Samuel S. MacKeown.)

dient in that column. Under the heading "Calc lation of Specific Gravity" it reads, "Pressure dr 33.1 pounds per 100 feet. Therefore the speci gravity equals 31.1 divided by 43.43, equals .762 And then below that "Baume equals 53.75 degrees Baume is a density scale, or a scale of density us commonly in the oil industry.

We have here, then, a pressure drop or pressu gradient giving the specific gravity, which is t density of the oil in that column or the fluid in th column, referred to water as 1, that the fluid in th column has a density of 76/100ths of water. It lighter than water. And also the density given Baume.

Curve 2 is for the gradient or density when t well is flowing. The right-hand portion of th curve, referring to the column at the lower pa of the well, is a straight line and is parallel to t curve 1. That indicates that in that portion the well, the lower portion of the well, there is n gas and that the fluid column consists only of t liquid oil, and that portion of the curve is marke "Oil column".

At approximately 2700 feet on this curve there a point which is marked, "Breaking point in curv Gas starting out of solution," and from that poin to the top of the well that curve gradually change it isn't a straight line but [417] has a small amoun of curvature. That means that in that portion o the curve the density does not remain strictly con stant, but decreases as you go up in the well. Tha

(Testimony of Samuel S. MacKeown.)

is because the liquid in the column is moving from a point of high pressure at the bottom of the well to a point of low pressure found up in the column. The pressure in the fluid is constantly reduced and the gases, which were dissolved in the fluid in the oil at the higher pressures, now can come out of the liquid, and that gives a change in the pressure gradient or density of that oil in this flowing column.

The density at any point can be determined by taking what is spoken of as the slope of this curve; even though it is not a straight line it is easy to determine the density at any point. I should say that the curve 2 is taken for a flowing well; that is, a well which is not being pumped but in which the oil moves up to the surface by the pressure in the formation.

On page 159, at the bottom of that page, it reads: "Fig. 1 illustrates an actual test performed on an East Texas well. The static gradient indicates the well to be of the semi-artesian type, inasmuch as the pressure is insufficient to raise the column of oil to the top of the hole."

Evidently this is not a complete flowing well, and probably operating by gas lift. I was incorrect when I said it was a well which flowed simply from the pressure of the formation. [418]

"By projecting the static oil column gradient downwards, the point at which the curve crosses the horizontal axis would indicate the height in the tubing to which oil could be sustained by the exist-

(Testimony of Samuel S. MacKeown.)

ing formation pressure, if the gas on top of the oi column were released. As previously mentioned, th gravity of the oil may be calculated from the stati gradient."

The static gradient is that obtained from curv 1, and is that given in the calculation. It mean the pressure gradient under static conditions, an it is calculated there as the pressure drop per hun dred feet and is actually 33.1 pounds per hundre feet. That is the value of the pressure gradien under static conditions.

"If any appreciable amount of water happene to be present at the bottom of the hole it would b immediately reflected by showing a curve of eve greater slope than that for the oil column."

That is a condition that sometimes exists in an oi well where you have water separating out at th bottom of the well. In that case, under no condi tion is the density of your fluid constant through out the column, because you have two differen liquids, water at the bottom and oil at the top. Bu that is not shown in this curve.

Then reading on, the second paragraph on pag 160:

"The flowing gradient in this same figure is o interest in that through it several theories ar substantiated." [419]

The flowing gradient is the pressure gradient o the density obtained from curve 2 where the oi is flowing.

(Testimony of Samuel S. MacKeown.)

"It is seen that for a distance of nearly a thousand feet up from the bottom of the tubing the flowing gradient is a straight line and is parallel to the static gradient. The gradient then breaks off into a curve with a gradually decreasing slope."

That fact, that it has the gradually decreasing slope, means that the density of that column is gradually decreasing. Then continuing:

"The only logical way of interpreting this curve is that all gas is in solution in the formation and that it remains in solution for a considerable distance up the tubing. When a point in the curve is reached at which the pressure approximages 700 lbs., gas starts out of solution. As the pressure decreases upward in the tubing more and more gas is liberated from solution, thus causing a corresponding lightening effect of the column. Emphasis is placed on the fact that this chart represents no mere coincidence, for the conditions as shown in these curves are duplicated in almost every test performed in the field."

So this article shows how it is possible to obtain the density from a curve of pressure and depth by taking the slope of that curve, and that in a flowing column of oil in which no gas is being evolved, that the density is the same as in [420] the—let me correct that—this shows that where the fluid column is a liquid and there is no gas in it, the density is the same as you would obtain in the static condition; that as gas comes out of solution from the liquid, then there is a decrease in

(Testimony of Samuel S. MacKeown.)

the density of the fluid, that fluid being then a mixture of gas and liquid.

Q. You have said from that curve that you can do certain things. How is that curve plotted?

A. This is curve Fig. 1 on page 153. That is the only figure that we have referred to in this article. That curve is plotted in pressure in pounds per square inch against well depth in feet. I might say that curve 3 of Fig. 1 which is in the upper left hand corner, is a plot of production in barrels 14 per hour against the bottom hole pressures in which the productive index of the well can again be obtained. The values for the abscissa now are in the top of that curve, giving the production in barrels per hour.

Q. Now, will you take the article of Ihrig, or the article written by Ihrig in the Oil and Gas Journal; it is Defendant's Exhibit K-5; and compare that with the disclosure of the reissue patent in suit.

A. This is a one-page article which gives an account of the determination of the bottom hole pressure in an oil well under two rates of production, and shows how these bottom hole pressures can be used to determine the maximum production [421] from the well. This well produces both water and oil. The Fig. 1 is seemingly the actual record obtained from the pressure recorder which was in the well during these tests. The pressure recorder ran for some 39 or more hours, and gives a graphic plot of the pressure existing in the

(Testimony of Samuel S. MacKeown.)

fluid as time goes on. The left hand part of that curve shows a rapid increase in pressure, which is when the pressure recorder is lowered into the well; then the well is started pumping and the pressure decreases and becomes a constant value after approximately 15 hours. The pump has been on a constant production rate and it has taken that long for the equilibrium or stable conditions to obtain; and from that time onward as the rate is kept constant you obtain a bottom hole pressure, which is the bottom hole pressure under equilibrium or stable conditions. That gives a pressure, then, at that rate of about 190 pounds. Then the production rate was changed and another reading was obtained at approximately 30 hours after the start of the record for another rate of production. On Fig. 2 these results are plotted.

As I stated, the well makes both water and oil, and we have the two points on each of those curves giving the rate of production of oil at two different bottom hole pressures and the rate of production of water at two bottom hole pressures. The lower curve, which shows less production, is for the oil, and the higher curve is for the water.

I might remark that this Fig. 2 in this Defendant's [422] Exhibit K-5 is identically the same as Figs. 4 and 5 of the reissue patent 21,383 with the exception that it is turned around. In other words——

The Court: It is upside down?

A. Turned upside down.

(Testimony of Samuel S. MacKeown.)

Mr. Graham: Doctor, will you take the article by William Victor Vietti, Defendant's Exhibit K-9 and compare it with the disclosure of the reissue patent in suit?

A. This is an article entitled, "Density of Oil-Gas Columns from Well Data", and describes a method used by Vietti to determine the density of a column of fluid which contains oil and gas. The method he employs is shown in both Figures 1 and 2. What he does is plot the casing pressure against the production in barrels per hour, then he extrapolates this curve down to zero production, that is until it hits the abscissa line in the lower left hand corner. That value gives him the casing pressure that exists when there is a column of both gas and oil in the tubing even though the production is zero. That is obtained by extrapolating this curve downwardly. It is actually a different value than he would obtain if he closed down the well, because in that case the oil and gas would separate and you would have a liquid column and a gas column. But by taking these values at different rates and then extrapolating it down to zero flow he can obtain the casing pressure which would exist at zero flow if you had [423] the mixture of liquid and gas in your fluid column. Now, he knows the pressure in the formation or what he calls the shut-in pressure or rock pressure, and from those data, the rock pressure and the casing pressure and zero flow, he is able to calculate the density of this mixture of gas and oil. That is

(Testimony of Samuel S. MacKeown.)

explained in the next to the last paragraph on page 216, which states:

"The subtraction of the shut-in pressure thus found from the measured rock pressure of 700 pounds per square inch gives us the pressure exerted by the fluid column (X pressure). Some error is involved by the fact that flow starts somewhere back in the formation and not at measurable points such as the top of the pay or bottom of the hole. Dividing the weight of the fluid column by the distance to the point of entry to the well bore gives us the average weight per foot of the fluid column. The average density of the column can then be calculated. These were calculated on the distance to the top of the first flowing zone and the total depth of the wells."

The Court: "Dividing the weight of the fluid column by the distance to the point of entry to the well bore"— Where is that point of entry to the well bore?

A. Let us assume that the point of entry is where the perforations are. He was measuring from the top of the well to that point, and dividing the pressure of this column which he has obtained by subtracting the casinghead pressure from [424] the rock pressure by the height to obtain the pressure gradient or the density in the mixture of oil and gas existing in that column.

The Court: What is the difference between the weight of the fluid column and its density?

(Testimony of Samuel S. MacKeown.)

A. The weight of the fluid column per 100 feet is spoken of as pressure gradient, and is proportional to the density.

Mr. Graham: Q. What is the difference between density and weight?

A. The weight of material is actually what it weighs, but density is weight per cubic foot. If we speak of weight of the column of gas, the weight of 100 feet of that pressure exerted by 100 feet of that is spoken of as the pressure gradient, and it is proportional to the density of the fluid. It is not the same value, but it is proportional to it.

The Court: Q. He has used weight per foot and density simultaneously.

A. They are the same, except they are expressed in different units, and consequently have a different numerical value.

Q. The average per foot of the fluid column would be identical with the average density?

A. Not numerically, but they would be for all intents and purposes. In other words, the density is the weight per [425] cubic foot; in the case of water it is sixty two and a half pounds. The gradient of the column of water, the pressure gradient or the weight per foot is .43 pounds. They are different numerical values, but they are proportional, one to the other. You can easily convert one to the other, and I think for all intents in this case they are the same, because it is easy, if you know it, to obtain the other pressure gradient.

(Testimony of Samuel S. MacKeown.)

The Court: Is there any way of proving these things, or is this a mathematical calculation?

A. These are taken from several wells, and he has given in Table 2 tabulations, and I don't know how well accepted this is. Seemingly, Vietti seems to think that this is a reliable method of getting such information about the average pressure gradient or average density in a mixture of oil and gas, or I don't think he would have published it.

Q. Do you think it is?

A. Yes, I think it gives information, particularly in this field.

Q. Is it accurate?

A. I don't know how accurate it is. He has a great many points on this curve on top of Fig. 3, and it seems that they are scattered around that line, and he has drawn a line which I think we can take as an approximate value from these data. [426]

Mr. Graham: Q. I have one more, the Tucker article, Defendant's Exhibit K-4, which appears in the Journal of the Royal Society of Art, 1923. That refers, I believe, to the hot wire microphone. Will you just refer briefly to the pertinent parts of that, Doctor?

A. Yes, I can be very brief with this article, because this describes the microphone and the acoustical resonator which were described in his patent. I would like simply to refer to page 122, to the short paragraph in the second column. The first paragraph, starting in the second column, which states:

(Testimony of Samuel S. MacKeown.)

"Mere noise, however, does not produce an appreciable effect, as can be shown by sounding a klaxon horn in the immediate neighborhood of the microphone."

And I would like to read the next sentence in the first paragraph:

"The selective character of the microphone may further be illustrated by contacting it with the solid-back carbon microphone. In July of 1916, I was able to take parallel records of sound at Mount Kemmel with these two instruments. (Fig 2)".

And then at the bottom of the page is a curve that is printed Fig. 3, and then in my copy is crossed out to be Fig. 2, and it has the caption: "Records of Two Gun Sounds, with Hot Wire Microphone and with solid back Carbon Microphone".

[427]

There is a comparison of the response of the two microphones. The upper curve of that one strip (next to the lower strip on P. 122 of article) shows a record made by the hot wire microphone, and shows, with the exception of the two shots, one about one-third the way along the strip, and the other a little bit more than two thirds of the way, a record relatively straight, and it is not marked by disturbances. The lower one shows a record made with a carbon microphone, which does show the two shots, and it also shows a lot of other irregularities.

There is one other point in this I would like to take up, to clear one question that your Honor

(Testimony of Samuel S. MacKeown.)

had the other day. I will read just a sentence, starting in the last line on page 124 of the Tucker article, which states:

"One effect, however, must be particularly referred to, viz., that the microphone wire is indifferent to the direction of the disturbing blast, since in both cases the wire is cooled, the resistance is diminished, and the record shows a succession of peaks entirely on one side of the zero line."

And then in Fig. 12 he shows a record made of the current in the hot wire microphone, and in the upper curve, which is marked "Grid Vertical" you see that all of the changes are above the zero line which is shown at the left of that curve. Actually, each of the peaks of this curve represent not only a pressure pulse, but also a rarefaction. The valleys in that [428] curve represent the period between a pressure wave and a rarefaction, when no air is passing through the microphone. The reason why the curves made by defendant's apparatus do not look like this is because a transformer is incorporated in that apparatus, which takes away the slow changes of the base line, and you only see the variations. This curve is actually taken from the current in the microphone itself, and there is no transformer interposed between the microphone and the recorder.

The Court: In 12 (a) each one of these peaks is alternating, high and low, high and low. Is the high one the positive, and the low one the negative?

A. No, your Honor, the first high one, say, is

(Testimony of Samuel S. MacKeown.)

the positive; the second higher one the negative; the third higher one a positive, and the fourth higher one a negative.

Q. Why are these alternately smaller, and they all seem to hit about the same space, and it is completely regular, as to high and low?

A. If you will think of blowing through this microphone, you first blow through it and then suck. When you blow you put air through it. That gives a peak increase. The current then, when I stop blowing or sucking, the current decreases to its minimum. Then when I suck through it, I get another peak, so there are actually twice as many peaks on this as there are peaks of the pressure. Each one of those peaks [429] refers to the peak of the pressure, and also to the rarefaction. I think that answers the question you had the other day regarding why the defendant's curve did not show the characteristic action of this microphone.

Mr. Graham: I would like to straighten this out, Doctor, on page 122 at the bottom there are three records. There is some confusion about the numbers on these in my copy. Now, the one that you are testifying to is the second one from the top, isn't it?

A. That is correct. Unfortunately, I think in a misprint that was marked Fig. 3 in the printing; then somebody has changed that in pencil or pen to be Fig. 2. That is the one I am referring to.

Q. Doctor, there has been testimony here by Mr. Cornes about some tests that were made back in

(Testimony of Samuel S. MacKeown.)

Duncan, Oklahoma, with an apparatus built according to the disclosure of the Wyatt and Lehr patent. Were you there at the time of those tests?

A. Yes, I was. I participated in the making of those tests. I examined the apparatus that was used in the making of those tests. That apparatus was made in accordance with the Wyatt and Lehr disclosure of the pressure cylinder, and so forth.

Q. There are two photographs in evidence as Defendant's Exhibit H, and Defendant's Exhibit I. Will you please look [430] at those, and tell me if you can state what they are?

A. These are photographs of the apparatus set up in this well in Duncan, using the impulse chamber which is here in court, and as described in the Wyatt and Lehr patent as using, in the one case, that shown on Exhibit I, the carbon microphone, and that shown on Exhibit H, the hot wire microphone.

Q. Was the apparatus used, in so far as a means for introducing a pressure impulse into the well and the receipt of the echo from that impulse, the same as that disclosed in the Wyatt and Lehr patent?

A. Yes, and particularly that disclosed in Fig 2 of that patent.

Q. Doctor, the Wyatt and Lehr apparatus used there at Duncan, which you have just testified to, and which you have testified was operated by yourself and Mr. Cornes, did that apparatus record an echo from any tubing collar so that the distance

(Testimony of Samuel S. MacKeown.)

to the fluid surface could be determined by count tubing collar echoes. A. Yes, it did.

Cross Examination

By Mr. Mattingly: Q. When you say this paratus that was tested in Oklahoma was built accordance with the Lehr [431] and Wyatt pat did you build the apparatus?

A. No, I did not build the apparatus.

Q. Upon what do you base your statement t the apparatus which was assembled and tested th was built in accordance with the Wyatt and L patent?

A. Upon an examination of the apparatus, particular tests, and the running of the ampli and recorder.

Q. I understand that the apparatus which tested in Oklahoma included a pressure chamb a bottle of gas, from which bottle of gas a cert quantity of gas was let into this steel cylinder pr sure chamber, and was discharged from there b quick opening valve into the casing of the well that correct?

A. Not quite. There was a pressure line fr one of the shops, so we did not need to use bott gas; we could fill the impulse chamber direc from the line; but with that exception that is c rect.

Q. The pressure line from the shop was used a source of gas to put into that chamber?

A. That is correct.

(Testimony of Samuel S. MacKeown.)

Q. In connection with that apparatus which you just described, a microphone was used, is that correct? A. That is correct.

Q. Will you state what type of microphone was used? [432]

A. It was an ordinary carbon microphone, one which was in use, one I think which was used in the communication system of the Halliburton Oil Well Cementing Company; one of their spares that they had for their ordinary communication system inside the company.

Q. Was that type of microphone available in 1933?

A. Oh, yes; it has been available for 50 years.

Q. That was the type of microphone that was on the market at least as early as 1933?

A. Yes; an ordinary carbon microphone, common in the ordinary telephone transmitter.

Q. What type of recorder was used?

A. The recorder used was the recorder in the Echo-Meter apparatus. The recorder worked on the dynamic principle, the same in principle, and the same in general operation as the loud speaker diaphragms of practically every radio.

Q. Was a filter and amplifier used in connection with that recorder?

A. The test following the Wyatt and Lehr apparatus did not include the filter, but it did include the amplifier.

Q. Did the amplifier which was used in any way restrict or diminish the frequency response of the

(Testimony of Samuel S. MacKeown.)

recorder, the frequencies which would be com
back from the well which you were testing? [4

A. No. I did not personally make the test
the amplifier, but I saw a curve which Mr. Cor
made, which showed the amplifier itself gave a
sponse curve way out, very flat throughout the
quency range.

Q. Have you any idea when that type of
corder and amplifier assembly was first made; t
is, the one which you say is the Echo-Meter
plifier and recorder?

A. Do you mean the actual apparatus built t
was used, or when the type of amplifier and t
of recorder was first made?

Q. When was this particular one made; do
know?

A. I don't know. I think fairly recently.
was the one that is in court here. I believe t
is the actual recorder and amplifier that was u
at Duncan. Mr. Cornes so informed me.

The Court: You refer to one that is in cou
There was one that was demonstrated here. W
it that one or some other?

A. It was that one, and that one is still in cou

Mr. Mattingly: What I am referring to is
part of the apparatus which feeds the paper p
the pen. The pen and the mechanism upon wh
the paper is moved sidewise under the pen.

A. I don't know when that particular record
with all [43] of the details there contained, t
mechanical details and method of suspending t

(Testimony of Samuel S. MacKeown.)

paper, and so forth, was first designed. I know approximately when reproducers employing that principle were first used.

Q. You mean the loud speakers employed in radio reproduction?

A. Yes, and a little bit more than that. I mean with exactly the same type of magnetic circuit and electrical circuit, and so forth.

Q. Would you say that a pen and paper recorder of this type, which includes a stationary pen, the sidewise movement of the paper caused by an assembly you refer to as like a loud speaker, would you say that a particular recorder of that type was available on the market in 1933?

A. I don't know.

Q. Isn't it true that there was no such recorder available at the time? A. I don't know.

Q. The first time you ever saw one was when you started to work on this case; is that correct?

A. Well, the first time I saw one identically with this design and just this way, was in this box, yes.

Q. This recorder does have the characteristic that it has a very rapid speed response, does it not? [435]

A. I don't think it has a very rapid speed response. It has rapid enough speed response to get through everything that the microphone will pass, but it has not got a rapid speed response, compared to, well, let's say the ordinary loud speaker in a radio.

(Testimony of Samuel S. MacKeown.)

Q. It does not have the same speed resp as that?

A. No; because the mechanical system has n inertia and consequently, cannot respond to as h frequencies.

Q. Then this recorder would not respond to record sourd frequencies that would be super posed upon the echoes of the gunshot from the ing collars and the other obstructions in a w would it?

A. Yes, I believe it would. I believe it wo respond to certainly the lower frequencies th It will respond to everything that the microph will respond to.

I was thinking, Mr. Mattingly, if I may m a statement, when I spoke about microphones I thinking of the hot wire microphone particula that probably will not respond to all frequen passed by the carbon microphone. It will resp to the lower audio frequencies.

Q. Then I believe you have answered the qu tion that I was about to ask you, and that is whet or not these charts, Exhibits F and G, which supposed to be charts made with the so-called paratus that was constructed in accordance w the [436] Lehr and Wyatt patent, those charts not show those super-imposed sound frequencies the wiggles that represent the echoes from various things that were in the well?

A. They do show sound frequencies, the f

(Testimony of Samuel S. MacKeown.)

quencies which are in the lower part of the audible range.

Q. Will you point out what some of those frequencies are in these charts, and will you mark them as you find them?

A. There are frequencies present within this which, from peak to peak, are pretty close, and the tubing collars are, I believe, 30 feet apart. I think that was what Mr. Cornes testified. So that this being open to the air, the speed of sound would be some thousand feet or eleven hundred feet per second. So that we can determine the frequencies of the individual echoes from the tubing collars. Those are easily counted on this, and in between those are very much faster frequencies which would be up in the audible range; the frequencies are probably some place between 50 and 100 cycles. Those are indicated by what you might call the more rapid wiggles on the curves.

Q. Will you point out where some of those frequencies are, those wiggles you have referred to, and mark them?

A. I am referring to Defendant's Exhibit G. I can mark with a red pencil those that are discernible, Mr. Mattingly. Over in a range which I have indicated by a bracket, a number of peaks are pretty close together. They are not regular [437] peaks. They consequently include frequency waves relatively high.

The Court: That is, those short peaks. That is,

(Testimony of Samuel S. MacKeown.)

the bracket includes two long peaks and three short ones, is that right?

A. Yes. There are frequencies in there which certainly run to 100 or 200 cycles per second, and the only way you can determine what frequencies are recorded would be to apply Fourrier's analysis, and in that way find out what frequencies are present, but I know by looking at that, and having a rough idea of the frequencies between the main peaks that frequencies are possible that will run up several hundred cycles per second.

Q. Which peaks are tubing collars, the short ones or the tall ones? A. The tall ones.

Q. So in the bracketed portion which you have indicated in red, we will call X on this diagram, there is only one length of tubing?

A. There would be at least two lengths of tubing.

Q. There is one from here to here; from one high peak to the other high peak?

A. I think, your Honor, there would be another peak in here, which may be partly masked by these higher frequencies, because the rest of the curve shows that the space between the [438] two peaks you speak of is a space where you would expect another one.

Mr. Mattingly: Q. There should be one in that space, but it did not register as a distinguishable peak in this record, did it?

A. It is there, but these higher frequencies may have superimposed on that, and cut down that peak at that particular point. These higher frequencies

(Testimony of Samuel S. MacKeown.)

you ask about, which this microphone reproduced, which are recorded on the record, are superimposed on other frequencies, and sometimes you will miss one of the tubing collars, but you know it is there. It is like a picket fence. If you know a picket is out of a picket fence, it does not cause you any difficulty in knowing that a picket should be there; if you wanted to measure the distance by counting the number of pickets you would include that in your computation. They are regularly spaced, and you would know one is missing. I think Mr. Walker spoke about that on the upper part of the curve, where he said there were a number of disturbances but that did not cause any difficulty in counting the tubing collars, because you know how many should be in there.

The Court: The witness said "This microphone". Are you still talking about the carbon microphone?

Mr. Mattingly: Let us ask Doctor Mackeown: Are you still talking about the carbon microphone?

[439]

A. I am, because this defendant's Exhibit G was made with a carbon microphone.

The Court: What causes these sound frequencies that are superimposed on the tubing collar echo?

A. Those came from possible low frequencies present in the sound of a gun shot. This was not the sound of a gun shot—or from the opening of the chamber itself, or from some other disturbance.

(Testimony of Samuel S. MacKeown.)

I don't know just where they came from, but they are higher frequencies which are present.

Q. Those are all echoes? Every variation in that line represents an echo?

A. Yes; it must be an echo from something as soon as you get away from the starting point.

Q. There must be an obstruction?

A. Not necessarily, your Honor, because they may be echoes of higher frequencies; that is noise present due to the noise incident to the opening, or this pressure impulse being applied, which will register those as well as the echoes from the pressure impulse. Mr. Mattingly has been asking me whether this record shows and can register audio-frequencies; whether the recorder, amplifier and microphone used in this apparatus were capable of measuring audio-frequencies. I told him it was, because there is present in this record a record of audio-frequencies. Those are [440] things he is questioning me about now. These short frequencies have irregular waves in between the peaks due to the reflection of the pressure impulse from the tubing collar.

Mr. Mattingly: Q. I want you to mark on there what you think are tubing collar echo records.

A. Do you want to simply know those where I know there must be one but it is not obvious?

Q. You have testified from that record you can tell the number of tubing collars that are in that well. I want you to point out to the court how

(Testimony of Samuel S. MacKeown.)

it is you can tell the number of tubing collars that are represented on that chart.

A. I have put marks on these tubing collar echoes which are obviously tubing collar echoes. There are certain places—there are about three gaps in there where I haven't put marks, where it is perfectly obvious that tubing collar reflections should be in between, because the space between the adjacent marks is approximately double what it is between the others. If you were interpreting this you would have no difficulty in knowing that there were tubing collar reflections present which were masked or hidden.

Q. In other words, knowing that you want to look for tubing collar echoes you would be able to guess those peaks which you have marked represent tubing collar echoes?

A. If I had no idea there were tubing collars there, [441] nevertheless, I could take that record and from the regularity between echoes it would certainly give me a clue that there was something giving me a regular echo, and it would be easy to determine the length between marks on the record, and from that the spacing between the objects which will give me reflections, and that would certainly give me a clue to the fact that it was tubing collars, because the distance I would calculate from this record would be the distance between tubing collars.

Q. These intermediate loops or wiggles that you have referred to as being these superimposed fre-

(Testimony of Samuel S. MacKeown.)

quencies here, that's the same sort of thing that M
Walker has referred to as hash; that is, it is the r
cordation of such wiggles on the line which tends
knock out any wiggle that would be recorded, a
therefore it has hashed up that part of the record,
that a good statement?

A. Well, it has kept the record from being
easily recognizable, as if they were not presen
that is true.

Q. That was with the carbon microphone th
Exhibit G was made? A. That is true.

Q. My notes show that Mr. Cornes testified th
Exhibit F was made with a hot wire microphon
and Exhibit G was made with a carbon microphon
Exhibit F, I believe it was testi- [442] fied, w
made with the hot wire microphone; is that correc

A. That is correct. That is the difference b
tween Exhibits F and G.

Q. Will you take Exhibit F and mark on th
exhibit what you consider are the tubing coll
echoes, in the same manner you marked Exhibit G

A. It is easier to mark them on Exhibit F th
it is on Exhibit G, because the hot wire microphon
does not pass the higher frequencies and, cons
quently, those higher frequencies are not recorde
I have done that on the lower part of this recor
Mr. Mattingly. I have not done it on the oth
part, as the clerk has put his stamp on that par

Q. I would suggest that you mark the enti
length of that record strip to show all the collar
so that we can see how many there were.

(Testimony of Samuel S. MacKeown.)

The Court: These were made in the same well, as I remember the testimony.

A. They were, your Honor. I was there.

Mr. Mattingly: I offer the photostatic copy of Exhibit F, that the witness is now marking, as Plaintiff's Exhibit——

The Court: F-1.

Mr. Mattingly: I would like to offer that as Defendant's Exhibit F-1.

The Court: Yes. F-1.

[Printer's Note: Defendant's Exhibit F-1 is set out in full in the Book of Exhibits.] [443]

A. I have marked with red pencil on this exhibit a number of tubing collar reflections that are plainly discernible. There are several places, particularly up near the first part of the record, where it is not easy to pick out those tubing collars. I had previously on this record, when I had it in my possession, counted out ten of those tubing collars, and I know the distance that ten of them occur. Consequently, I know the distance that there should be between the spacing of any two tubing collars. So that I can very readily tell, if there is a gap, whether there should be one or two or three, or how many tubing collars in that area.

Q. Will you mark on this record, Exhibit F, the initiation of the pressure impulse and, also, the recordation of the echo from the fluid surface? Mark the initiation of the shot as "A".

A. I have done that.

(Testimony of Samuel S. MacKeown.)

Q. And the echo from the fluid surface as "B".

A. I have done that.

The Court: Which on the original exhibit is marked "Valve opened" and "Fluid level echo". The initiation of this shot is "A", and the fluid level is "B". How many tubing collars are recorded on that strip, Exhibit F, between the opening of the valve and the recordation of the fluid surface echo? [444]

A. What do you mean, "are recorded"? Do you mean that have definite positive indications that they are there, or how many actually exist between those?

The Court: Well, I guess he wants you to count the number of marks on there. Isn't that what you want? You have asked him to indicate where the tubing collar echoes are.

Mr. Mattingly: He has marked the strip here with a number of tubing collars and echoes, and then he says there are a number missing from the record. And I want to know how he can count the number of tubing collar joints from that record.

A. I have counted here, Mr. Mattingly, and I have clearly marked 14 tubing collars. If you think of this as a picket fence, for instance, you will notice that over a large portion of this you have a perfectly regular occurrence, and you can measure the distance between those. I have done that actually from that record, and you can see the calculations I have made there. Consequently, it is perfectly easy to know where tubing collars must

(Testimony of Samuel S. MacKeown.)

exist, even though they are not recorded, because you supply those just as you would supply pickets in a picket fence; if you want to measure it you would know where they should go.

Q. In other words, you add to the record that you have, such as Exhibit F, the additional information that there must be some more tubing collars in the well, and then you merely [445] measure off what you think is the space that should be occupied by those and fill those in mentally; is that right?

A. Well, you use your head in interpreting that. Yes; that is approximately correct.

Q. Then with this apparatus that was tested in Oklahoma, you selected there a recorder which, as far as you know, was not available on the market in 1933, and for making Exhibit F you selected the same microphone which the defendant is using now, a hot wire microphone. Will you please state whether or not that hot wire microphone was an article of commerce and available on the market in 1933?

A. It was certainly easy enough to build one. I don't know whether any concern had gone into manufacturing them and advertising them; but exactly how to build them had been described in a number of articles written by Tucker and Parris; a lot more than have been talked about in this case. There is nothing new about the recorder, except that I don't know that this particular design, in all details, was available in 1933.

(Testimony of Samuel S. MacKeown.)

Q. Can you account for the fact that on the record strip, Exhibit G, there was not recorded a great many more additional peaks or hash, such as is shown on Plaintiff's Exhibit 20?

A. Well, I don't know what the arrangement was in making [446] Exhibit 20. In know, in glancing at one of these exhibits, there was an awful lot of hash prior to what I thought was the initiation of the impulse, which would seem to indicate that there must have been a lot of vibration or other noise existing even before you put any noise down in the well. On one of these records I got the indication that that was the case, but I don't know what the arrangement is on this exhibit.

Q. Then you don't know whether or not the construction of the recorder which was used in these tests in Oklahoma, was such as to tend to damp out or prevent the recordation of these additional noises that would appear in the well, do you?

A. Well, I am pretty sure that it was fairly well damped, as you would want it to be. If it wasn't its own frequency, its own oscillation is going to introduce a lot of spurious effects, which may have been the case with the oscillator that was used in making these other exhibits that you have asked about.

Q. You have testified that the apparatus which was tested in Oklahoma was built in accordance with the Lehr and Wyatt patent. Will you explain to the Court what you mean by "in accordance with"?

(Testimony of Samuel S. MacKeown.)

A. Are you speaking now only of the recorder or of the whole system starting from the microphone?

Q. I want you to explain what you mean by "in accordance with the Lehr and Wyatt patent"? [447]

A. All right. The Wyatt and Lehr patent shows, in Figure 2, as far as the recording system goes, a microphone. There are no specific instructions given regarding the microphone. That microphone is shown as 15 in Fig. 2. So that we used a microphone; we used the most common type of microphone; that is, the carbon microphone. And we used a microphone, also, which was known long prior to Wyatt and Lehr's patent, which also had been shown to be particularly useful in recording gun shots. We used two different things. Then, 18 is shown to be an amplifier with no details, at all, regarding the amplifier. And we used an amplifier that was available that had a response throughout certainly the major portion of the audio frequencies. 16 is a recorder, and that recorder is described on page 2, column 2, starting at line 21:

"The recorder 16 illustrated may be provided with a pen arm 21 which would be controlled by an impulse in the circuit 17, and this pen arm would carry a pen or pencil 22 to run on the face of a recording drum 23 mounted to rotate on its horizontal axis and bearings 24."

Wyatt and Lehr here give, as an illustration, a type of recorder which can be used where a pen or pencil moves across a moving strip of paper to

(Testimony of Samuel S. MacKeown.)

give an ink trace of your motion. We had available a mechanism in which the paper was moved, rather than the pen. There is no difference, parti- [448] cularly, in doing one or the other. This was available and certainly, I believe, it is a perfectly fair representation of the recorder arms in the Wyatt and Lehr patent. Whether the paper moves relative to the pen or the pen moves relative to the paper, it is the same thing.

Q. But you did not, in assembling that apparatus, attempt to find a recorder which was available or on the market in 1933 at the time the Lehr and Wyatt application was filed, did you?

A. No. There were such recorders and we could have done that, but it did not seem necessary.

Q. Did you ever see any apparatus constructed by either Mr. Wyatt or Mr. Lehr, or both of them, in accordance with the Wyatt and Lehr patent to which you have testified?

A. No, I never saw any apparatus constructed by either Mr. Wyatt or Mr. Lehr.

Q. I want to refer to the article by Tucker, about which you testified, Defendant's Exhibit K-4. In Figures 12A and 12B on page 126 of that article, the type of record there is a record of a continuous sound, is it not?

A. A continuous sound, yes.

Q. As distinguished from a pressure impulse or a gun shot? A. Yes.

Q. In neither the defendant's apparatus and

(Testimony of Samuel S. MacKeown.)

system, nor [449] in the plaintiffs' apparatus and system, is there a mere noise used, is there?

A. No, in neither one; just a sound without a pressure impulse accompanying it. That's true.

Q. Both the defendant and plaintiffs use a pressure impulse which may or may not be accompanied by sound? A. That is correct.

Q. I believe in the demonstration we made in court both were accompanied by sound.

A. They were.

Mr. Graham: We offer in evidence file wrapper of application 171,170, as Defendant's Exhibit Q. And that became abandoned, your Honor. That is a certified copy of the file wrapper.

[Printer's Note: Defendant's Exhibit Q is set out in full in the Book of Exhibits.]

The Court: When was that abandoned?

Mr. Babcock: April 20, 1939.

Mr. Graham: That was a written abandonment filed by the inventor, I believe, as appears in the file wrapper.

I offer in evidence a certified copy of the file wrapper of patent No. 2,161,733, as defendant's Exhibit R.

[Printer's Note: Defendant's Exhibit R is set out in full in the Book of Exhibits.]

The Court: The application is Serial 268,805?

Mr. Graham: That is correct. I offer in evidence a certified copy of the reissue patent in suit;

(Testimony of Samuel S. MacKeown.)

the file wrapper, which as your Honor has noted, had a serial number of 307,551.

The Court: That is "S" in evidence.

[Printer's Note: Defendant's Exhibit S is set out in full in the Book of Exhibits.] [450]

Mr. Mattingly: Referring to all three of these file histories that are now in evidence as Defendant's Exhibits Q, R and S. Would your answer be that you had read all three of those file histories?

A. There was a great deal which I did not read, but I glanced through all of them.

Q. You did not notice whether or not this Vietti article, Exhibit K-9, was cited by the Patent Office as a reference during the prosecution of that application through the Patent Office?

A. I don't recall that I did.

Q. In the article by Vietti he is referring to conditions existing in flowing wells, is he not, as distinguished from conditions which might exist in wells which are being pumped by a mechanical pump?

A. Well, he is speaking primarily, as the heading shows, of the density of mixed columns of oil and gas. His data comes from flowing wells; that is true.

Q. And he describes in this article the determination of what he calls the "average density". Is that correct? A. Yes, he does.

Q. That is, the average density of the column of mixed gas and oil which is extended up into the well? A. That is correct. [451]

(Testimony of Samuel S. MacKeown.)

Q. Is that column of mixed oil and gas moving up through the well or is it stationary, static?

A. That is a rather interesting question. He obtains this from taking measurements when the column is moving, and extrapolates it down to when there is no movement. Now, this can, I think, most correctly be said to be a limit which is approached as the movement is decreased and approaches zero.

Q. By "average density" there, he is indicating that the actual density at any given time in that column of mixed gas and oil, that he is referring to, is actually a curve, and he is merely trying to determine what the average density would be, rather than to determine that the density is constant throughout the height of the column; is that correct?

A. I don't think there is anything in here which indicates that he thinks it is a curve. I didn't notice any place. He does speak about the average density of the column, but whether or not it is constant or variable I don't think he states.

Q. Well, he doesn't state in his article anything which would indicate that he understood or realized that the density was constant throughout the height of that column? A. No, that is true.

Q. The graph which is shown on page 217 of the article K-9, referred to as Figure 3, "Weight of Fluid Columns of Varying Gas-Oil Ratios", the greater portion of the line which is marked on that chart appears to be a straight line. That is [452] correct, isn't it? A. That is correct.

Q. Now, this line is the result of measurements

(Testimony of Samuel S. MacKeown.)

which were taken from a number of wells, rather than a line which is produced by measurements taken only in one well; is that correct?

A. The data contained in that curve are from more than one well. There is more than one point from some wells, but that curve definitely does include information from more than one well.

Q. And that straight-line portion of that curve is in no sense a representation or recognition of the fact that the density in the gas and oil mixture in the column in the annular space between the pump and the casing has a constant value?

A. No. It is on an entirely different subject, actually.

Q. I would like to ask you at this time if you will state if you know how it was that Mr. Vietti arrived at what was the rock pressure in the wells that he was measuring.

A. The rock pressure is obtained by closing down the well and having, then, under static conditions a column of oil and a column of gas in the well. You can determine the bottom-hole pressure, which would be the rock pressure, adding to it the pressure due to your gas column and your pressure [453] due to your oil column underneath it. And that is the way that the rock pressure or formation pressure was determined, as I understand the article.

The Court: How do you know the height of the oil column?

(Testimony of Samuel S. MacKeown.)

A. That can be measured by any one simple measurement of the fluid level——

The Court: In a flowing well?

A. That well is not flowing at this moment. It is shut down, under static conditions.

The Court: What I mean to say, no pump in the well?

A. No pump in the well.

Mr. Mattingly: Q. I call your attention to the first line on page 216 of the Vietti article which states:

"The bottom-hole pressure has been determined to be 700 lb. per sq. in gauge." Doesn't that lead you to believe that he obtained that rock pressure, you have been referring to, by a gauge?

A. I don't think so necessarily, Mr. Mattingly. There is another sentence, down about midway of the second paragraph that would rather indicate that he obtained it by taking the fluid column after he had separated it into two parts of oil and gas. This article itself is not explicit in stating just how he did obtain the bottom hole pressure. It is not explicit in stating whether it was obtained by means of a pressure [454] recorder or by making a determination of the fluid level and taking into account the casinghead pressure, the gas column and the liquid column. It is not explicit which method he used to obtain his rock pressure.

Q. Rock pressure and bottom hole pressure, as they are used by the Vietti article, are synonymous, are they not?

(Testimony of Samuel S. MacKeown.)

A. Yes, they would be, I think. That was actually where he obtained his bottom hole pressure, under no-flow conditions, which would be the rock pressure.

Q. Mr. Vietti in this article does not mention any way of getting this bottom hole pressure and rock pressure by adding the gas column and fluid column to the effect of the weight of the gas column?

A. The article doesn't state which method he used.

Q. He could have been using a pressure recorder in the well; in fact, the first sentence on page 216, where he mentions a gauge, would indicate to you that in all probability he made his measurements with a gauge, would it not?

A. I will say yes to the first part of the question, but not yes to the last part. That is, it does not state that it was made by measuring fluid level, but that first sentence does not give me a great deal of assurance that it was made by a gauge. We often speak of pressure by gauge so many pounds per square inch on the gauge, without necessarily implying that it was measured by a gauge. [455]

Q. Then, all that the Vietti article describes that is of any value in this trial, is that at the time of the Vietti article he knew that there was a relationship between the bottom hole pressure and production rate?

A. No, not at all. I would like to give you one or two sentences of what I think the important part of this is. That is, that Vietti at this time

(Testimony of Samuel S. MacKeown.)

knew that when you had a lower density than the density of the oil alone, that you could obtain the value of the density by dividing the height of the column by the pressure exerted by that column.

Q. And that would give you the average pressure throughout the height of the column, but not necessarily a constant density value throughout the height of the column.

A. Yes, that would give you the average value.

Q. But not necessarily that the value was constant throughout the height of the column?

A. No, it might not be constant.

The Court: Was there some novelty in the idea that you could determine pressure in the bottom of the hole by having the weight of the substance, or the pressure of it?

A. No, there was no novelty, and for that reason Vietti never described in this paper how he did determine that bottom hole pressure.

Mr. Mattingly: Q. Where you say Vietti never described it, you mean his article is silent as to this method of obtaining [456] bottom hole pressure by adding the gas column and then adding the weight of the liquid column?

A. That is correct.

The Court: What did you state this was that you said the important part of the article was——

A. Can I say again what I said——

Q. Say it again, so that I can write it down.

A. That Vietti showed that the density of the fluid column made up of a mixture of liquid and

(Testimony of Samuel S. MacKeown.)

gas was not constant, but depended on the amount of gas in the liquid. That's the first thing. And that the average density of that heterogeneous fluid could be determined by taking the height of that fluid and the pressure exerted by the column.

Q. Yes. A. That's all.

Mr. Mattingly: Q. When Vietti expressed it this way, that if you know the bottom hole pressure, and you know the entire height of the well, and this mixture fills the entire well, you can get your average density by dividing the height of that column by the bottom hole pressure?

A. He goes a little further than that and says if he knows the rock pressure or bottom hole pressure at no-flow, which is a constant, does not change, that he can do it. He does not have to know the bottom hole pressure except for the no-flow. [457]

The Court: There is a third element; if he knows the bottom hole pressure, the depth of the fluid, and the casinghead pressure? A. That is correct.

Mr. Mattingly: Q. I refer you to the Hawthorn article. Did you, in your review of the file history, Defendant's Exhibits Q, R and S, note that this Hawthorn article was also cited by the patent office as a reference in each of those applications?

A. No, I did not, Mr. Mattingly. I did not make special notes on what articles were cited of the prior art. I may have known at the time, but I certainly don't recall now whether it was or not.

Q. The reference to wells that is made in the Hawthorn article is made to flowing wells rather

(Testimony of Samuel S. MacKeown.)

than wells that are being operated by a mechanical pump, isn't that true?

A. No, not flowing wells. For instance, the well we were talking about, which is shown in Fig. 1, page 153, is not a flowing well, but a well in which, when it is shut up, the liquid rises to a height of about 750 feet from the top. It cannot flow. That is definitely spoken of on page 159.

Q. Is that well, so far as you know, being operated by a pump?

A. I don't know whether it is being operated by a pump. [458] It might be being operated by a pump, or it might be operated by a gas lift. I don't know, but it must be one or the other.

Q. You referred to two curves on page 153 of that Hawthorn article. Do you know how the various pressures that are plotted on that graph, Fig. 1, were obtained?

A. Yes, Hawthorn obtained those pressures by using a pressure recorder.

Q. I refer you to Wilde and Moore's article, that is, Defendant's Exhibit K-1. Do you know how the pressures, or the bottom hole pressures referred to in that article were obtained?

A. No, I do not. I don't recall that Wilde and Moore describe the method they used for obtaining the bottom hole pressure.

Q. In any of the articles, or in the prior art patents that you have referred to in this case do you find any of them which gives a description of finding bottom hole pressure by first finding the

(Testimony of Samuel S. MacKeown.)

fluid level, and then adding the effect of the column of gas to the gas pressure at the casinghead, and then adding the effect of the weight of that liquid column below the gas? A. Yes.

Q. Where?

A. In the Gill article, which is Defendant's Exhibit K-2, in the second page of that photostat, which is page 28 of the [459] article, under the heading "D", this article tells of doing just that. Do you want me to read it?

Q. I wish you would read that portion of it which states what I have just asked you.

A. "In fields where the bottom-hole pressure is sufficient to support a solid fluid column to the surface, it has been found possible to calculate shut-in bottom-hole pressures with a considerable degree of precision from the surface pressure and the average specific gravity of the fluid column. A similar calculation can be applied in fields of lower pressure, provided the height of the standing fluid column can be accurately determined. This method is particularly applicable in East Texas, and affords a simple and rapid means of following changes in bottom-hole pressures."

In other words, in the second case he says that by knowing the fluid level you can determine the bottom hole pressure by taking into account the weight of the fluid and adding that to the weight exerted on the surface of the fluid.

Q. Would you mind going on with that quotation, to the next sentence?

(Testimony of Samuel S. MacKeown.)

A. "However, the calculation cannot be made until the average specific gravity of the fluid column has been accurately determined by actual measurement of bottom hole pressure."

Q. What do you think he means by "actual measurement of [460] bottom hole pressure"?

A. That some time during the operation of this field it is necessary to determine the bottom hole pressure probably by means of a gauge, and having once done that, and determined what was the density of that fluid column, then you can apply the other method.

Q. Is the fluid column he is talking about a column of dense fluid, or is it a column of mixed oil and gas such as we have been talking about in pumping wells, and described in the patents in suit?

A. It is a column where the oil and gas are separated.

Q. It is a dense liquid?

A. Yes. He can make a close approximation of the density of the liquid, by taking a column of oil with no gas in it, but since he seems to want to be very accurate in his determination of it, and the effect of the density, he takes a liquid column with no gas.

Q. Neither that article or the Vietti article does describe or teach how, without knowing the density of the liquid column, you can determine the bottom hole pressure by finding the fluid level and pressure at that fluid level, then changing the fluid level

(Testimony of Samuel S. MacKeown.)

and finding another fluid level and another pre sure at that fluid level, and thereby determinin your bottom hole pressure? [461]

A. No, I think that is correct.

Q. I refer you to the Halliburton patent, D fendant's Exhibit O-14, patent No. 2,201,311. believe you stated that the recorder which is i lustrated in the Halliburton patent, Exhibit O-1 was the same as used in the defendant's apparatu here, is that correct? A. In general, yes.

Q. Is this the same construction that is illu trated in the Halliburton patent as is that in th defendant's machine?

A. No, I simply meant by that it has all o the elements that are in the defendant's apparatu I did not mean each one of the elements had th same mechanical structure.

Q. What type of filter is illustrated in the Halli burton patent, Exhibit O-14?

A. The filter is indicated in Fig. 8 by a bo just a block diagram, and there is no definite in formation regarding the type of filter.

Q. That might be a filter which would operat upon the resonance principle, could it be?

A. I do not call in general anything that op erates on the resonance principle a filter. I think that is not good nomenclature. I think filters ar entirely different from resonance circuits. Mos of the text books so recognize it.

Q. How could a resonance circuit be used a

(Testimony of Samuel S. MacKeown.)

a filter to permit the passage through that filter circuit of certain [462] selected frequencies?

A. Practically it couldn't be in this case.

Q. Why?

A. Beause the filter for these frequencies, if you want to call it a filter, built as a resonance circuit would be so heavy, so clumsy, would have so much resistance, that it would be absurd to build it. It would be extremely expensive, and would not work well, and it would weigh many hundred pounds. A tuned electrical circuit for low frequencies is never built practically, because it is so heavy, so ineffective, because of the resistance that necessarily comes in in its construction that nobody uses it. A filter for the frequencies needed to count tubing collars, if it were built of a resonant electrical circuit, would weigh much more than the total weight of the recorder that is used in the Echo-Meter.

We could have an electrical circuit which is tuned, and resonant. You have that in your radio receiver. Those are the circuits you adjust to pick up whatever station you wish. For very high frequencies those work beautifully, they are very light, and don't have much resistance in them, and they tune very sharply. If you build up a circuit for various low frequencies, then the amount of what we call inductance or capacitance that has to be used becomes extremely large, and they don't work effectively, because the inductance, with such a large amount [463] of wire in it, and resistance in

(Testimony of Samuel S. MacKeown.)

it keeps it from being highly selective. It woul have very slight selectivity. It isn't sharp. Bu there are resonant electric circuits which a especially something like your accoustical tune resonator acts, but they are entirely different fro the electric filter. In other words, you have tune electrical resonant circuits.

Mr. Mattingly: Before we leave the Hallibu ton patent, there is one point I would like to hav cleared up; that is, you were speaking of the fr quencies that would be dealt with in the Hallibu ton patent. That frequency is extremely low i the Halliburton patent as compared with the fr quency of the occurrence of tubing collar echoes i the echo methods which are discussed here, is tha true?

A. Yes. The frequency that we have for thes individual knocks would be lower than the frequen cy you would have in either the Echo-Meter or th Depthograph.

Q. The reason for that is that as the plug i being pumped down into the well by this slug o cement behind it, or whatever is pumping it dow there, the passage of that through a joint of pip is relatively slow as compared with the rapidity wit which tubing collar echoes would be received at th ground surface in defendant's and plaintiffs' ap paratuses, is that right?

A. That is right, Mr. Mattingly.

Q. And the transmission of the sound whic is produced by [464] this plug passing the indi

(Testimony of Samuel S. MacKeown.)

vidual joints is through the steel of the drill string rather than through the gas which is the medium of transmission we are discussing here in the Echo-Meter and the Depthograph apparatus, is that right?

A. That's right.

Q. Take the Fessenden patent, Exhibit O-4. What would be the speed of sound from the sounding device 49 to the receiving device 14 shown in Fig. 1?

A. The velocity would be a whole lot higher than that in air. It would depend on the type of soil. It might be five or ten times greater than that in air.

Q. What would be the speed of sound from the sounding d vice 49 to the point marked 46 on the rock or ore depth 44?

A. If the material through which the sound travels was the same material as in another path, the velocity would be the same. The velocity of sound depends only on the mechanical properties of the medium transmitting it.

Q. Then the soil between the sounding device 49 and the receiving device 14 might all be soft sandy soil, and that would have one speed of transmission, or one velocity for the sound, would it not?

A. That would have a velocity for the sound.

Q. And the soil or ground through which the sound will travel from the sounding device 49 to the deposit 44 might be [465] of a different nature and harder nature, granite for example, or a mixture between one path might be granite, and the other

(Testimony of Samuel S. MacKeown.)

part might be soft soil, so that the velocity along the line extending from 49 to 46 might be totally different from the velocity along the line 49, is that correct.

A. It is possible it would be different. When you say totally different, I don't know what you refer to, but it is possible, if you would have a different type of soil in one path than in the other, there might be some difference in the velocity of the transmission of those two paths.

Q. Is there any way that a person using the Fessenden device would know the type of soil along each of those paths? A. Yes.

Q. How?

A. By the fact that he has one transmitter and four different receiving devices, each one of which is capable of giving him the velocity of the sound through the medium between the transmitter and those respective stations. So he would know very quickly, on his calibrating run, whether or not it was a homogeneous medium throughout the whole area, and if it wasn't a homogeneous medium, which paths give the greater velocity.

Q. If he only used the receiving station No. 14 and the sending station No. 49, if he only used those two he would not be able to accurately plot the distance or position of the ore deposit 14, would he?

[466]

A. He could if it were a homogeneous medium and the velocities were the same throughout. If it so happened that the velocity differed radically in

(Testimony of Samuel S. MacKeown.)

ifferent directions and he only had that one sta-
on, then he could not.

Q. In an oil well, on any single firing of a shot
nd making a record, doesn't the sound have to
o through the same gaseous medium in order to
et down to the known obstruction and back to the
round surface as it does when it goes to the ob-
truction at an unknown location?

A. I think the answer is no to that. In going
o the lower level, which we might call the unknown
bstruction, it goes through a path of gas which is
enser than any other part of the path, and there
s no part of the path going down to the known ob-
truction, which is higher, where the gas is as dense
as the part of the path going to the unknown ob-
struction, or where the temperature probably is the
same. This is true, I think: that the constitution of
the gas, what it is made up of, is the same; but
your temperature can very radically affect your ve-
locity, and your pressure can, to some extent.

Q. But for practical purposes, as described in
the patents in suit here, you could assume that the
velocity from the top of the well to the bottom of
the well and back, that is, the average velocity,
would be substantially the same to the unknown ob-
struction as to the known obstruction; isn't that
correct?

A. That will make, probably, some error, but it
may not be very large. It would be larger in the
case where you fire [467] a shell, I think, than in
the other case, because then you have in the upper

(Testimony of Samuel S. MacKeown.)

part of your column a region which may be hot, due to the effect of the shell.

Q. Doesn't the flame arrester, which is used in connection with defendant's gun, cool those gases down to a point where the temperature of the upper end of the hole would not be raised appreciably?

A. I don't believe so. All it does is arrest the flame. Certainly the gas coming out of there I would expect would be very much hotter than the gas ordinarily in the top of the well. And I think you will find that if you take the top part of these records, that your tubing collar distances, where you get good tubing collar distances, may give you a different value than if you go further down in the well.

Q. You referred to the Batcheller patent, Defendant's Exhibit O-2, and you stated that the Batcheller patent disclosed the same type of mechanical recorder that was shown in patent 2,156,519. Will you explain what you mean by "same type"?

A. Well, I think what I meant to say there was that Batcheller used a rather large diaphragm and has an all mechanical system, nothing electrical in it; which is the type of recorder shown in the 2,156,519 patent. I did not mean to say that the structure of the diaphragm and the individual elements are the same, but simply that they work on a mechanical principle with a lever linkage, which gives the increased movement, [468] in one case with a mirror and in the other case with a stylus. I think I

(Testimony of Samuel S. MacKeown.)

pointed out that in the 2,156,519 patent that the actual record is made by using a beam of light reflected from that mirror. By the use of the word "same" I did not mean it was identical. It was just generally a similar construction.

Q. I believe you stated that the hot wire microphone measured or responded to the velocity of the gas moving through the microphone?

A. That is correct.

Q. In that microphone as used in the defendant's device, how is the gas put into motion so that it passes through that microphone?

A. Well, the gas moves up from the well and is in motion, and moves through the diaphragm into the surge chamber.

Q. But what makes the gas move up from the well?

A. The initial impulse that was originally put into the well, and the reflection back.

Q. Do I understand you to mean that when the defendant fires a shot into the well up here at the top, that the gases from that cartridge go all the way down into this well and are reflected back, and still that bunch of gas comes back and goes through the microphone?

A. Not at all; but you can speak of either the pressure component or velocity component of a wave. And there is a wave [469] of velocity, as well as a wave of pressure, initiated by the impulse and travels down. There is a difference between them. You can say that the pressure impulse is the

(Testimony of Samuel S. MacKeown.)

result of the velocity impulse, or vice versa. Both are present, and I don't think there is any great difference between them.

Q. And both that pressure and velocity component is the result of the echo returned back to the ground surface of that gunshot or the slug of gas which has been introduced into the well?

A. Yes; and they travel with the same velocity.

Q. I believe you testified on direct examination that in connection with the use of a hot wire microphone it was necessary to provide a chamber or space at the rear of the microphone in order to permit that microphone to operate; is that correct?

A. That is correct.

Q. And I believe you said that in case of a diaphragm that space was not necessary; is that right?

A. That is right. There need be no space in back of the diaphragm for the gas or air to get through. You must leave a minute space back there to permit very small motion of the diaphragm.

Q. In other words, even on the use of the diaphragm it [470] would be necessary to have some small space at the rear of the diaphragm in order to permit the diaphragm to move under the influence of this echo which comes up against it?

A. That is correct, but no space for the gas to expand into.

The Court: No space comparable to the surge chamber?

A. That is correct.

(Testimony of Samuel S. MacKeown.)

Mr. Mattingly: Q. It does not have to be as large as the space of the surge chamber, such as would have to be used by the microphone?

A. That is right.

Q. But there would have to be some space to permit the diaphragm to respond to the echo which strikes it?

A. That is right.

Q. In connection with defendant's filter, I believe you testified that in the use of the filter by the defendant the filter was employed so as to pass back to the amplifier the frequencies of the tubing collar echoes, but would stop or choke off the frequencies which did not correspond to the frequencies of the tubing collar echoes; is that a correct statement?

A. No, you have got it just reversed. The filter itself does not pass the frequency that you want the amplifier to pass, and by not passing, allows the amplifier to pass that frequency. But the filter itself does not let that frequency through. [471]

Q. Is it true that the effect of the filter on defendant's amplifier system is to raise the tubing collar echoes above the level of the other noises or disturbances?

A. It is a little bit more accurate to say that the action of the filter is to cut down the disturbance more than to cut down the signal, because the filter itself cuts everything down, but cuts the unwanted disturbances more than the signal.

(Testimony of Samuel S. MacKeown.)

Q. Then, as I understand it, the effect of the filter in the defendant's system is to leave the tubing collar frequencies at a high level, but to suppress all the other noises or frequencies?

A. Well, pretty nearly that. It actually depresses the response of the tubing collars somewhat, but depresses the others more.

Q. So that the collar frequencies or collar echoes stand out above the other frequencies that would come up to the microphone?

A. That is correct. This all works after the microphone. There is no possible action of the filter prior to the microphone. The microphone receives everything that comes, and the filter works after the microphone only.

The Court: The filter works on the electric wire attached to the microphone? [472]

A. On the electric current, after the microphone has received everything that is put in the microphone.

Mr. Mattingly: Q. The microphone receives everything and passes everything to the amplifier-filter combination?

A. That is right.

Q. And in the amplifier-filter combination the amplifier and filter act to suppress all the unwanted frequencies and leaves the tubing collar frequencies at some distinguishable point above them?

A. That is correct.

Q. Do you know whether or not this diagram that you have referred to, following page 13 in

(Testimony of Samuel S. MacKeown.)

Plaintiffs' Exhibit 11-C—that is the Field Inspection Book—exactly represents the wiring of that filter and amplifier that is used and has been used by the defendant?

A. No. I can say this, Mr. Mattingly: That I have worked with this kind of a circuit used in an amplifier in this manner. I know how it operates. The only thing I can say is that I have been informed that this is the circuit, and my experience with the apparatus confirms that information, but I do not know that this is the wiring diagram of that circuit. I have not inspected the actual wiring of the defendant's instrument which is here in court. I have not taken it apart and traced it. I have never inspected the wiring in any of the other transducers which have [473] been used by the defendant prior to the introduction of the one which is in court. I have not traced out the diagram in any of those.

Q. With the wiring that is shown on the diagram immediately at the rear of page 13 of Exhibit 11-C, would that amplifier with the filter arranged in the manner shown cause the amplifier-filter combination to have a natural period of frequency or oscillation corresponding to the frequency of the tubing collar echoes?

A. This amplifier and filter combination will not of itself oscillate, if that is what you mean. If it is improperly adjusted, and if it does oscillate, it becomes an oscillator and is no longer an amplifier.

Q. Would that circuit, that is, that amplifier-

(Testimony of Samuel S. MacKeown.)

filter combination, tend to oscillate at the frequency from which the filter is set?

A. You can do this; with any amplifier you can arrange that amplifier by making certain changes in it so it would oscillate; then it would no longer be an amplifier, and if it did oscillate, this circuit would oscillate at the frequency the filter circuit passed, but the amplifier itself, if properly adjusted as an amplifier must be, will not oscillate.

Q. When you speak of properly adjusted, what do you mean by that? [474]

A. Properly adjusted; I simply mean that there is no positive feed-back in the amplifier which will cause it to become unstable and unsuited to operate as an amplifier.

Q. I call your attention to the diagram following page 13 in Exhibit 11-C, and particularly to that part of the circuit which is shown as including the branch that extends from the right hand wire filter circuit through what appears to be a 10,000 ohm resistor, and then through a 1,000 ohm resistor; then through a movable contact; then through a resistor R-2, the value of which is not recited there. Will you state what the effect of that branch of the circuit is?

A. The effect of that branch would be in general to govern the amount of energy that is fed back from the output circuit of the amplifier through the filter through the imput circuit of the amplifier.

(Testimony of Samuel S. MacKeown.)

Q. If there was an adjustment of the position of the movable contact which is indicated by that arrowhead immediately below the 1,000 ohm resistor would there be a tendency for this filter-amplifier combination to oscillate at the frequency for which the filter is adjusted?

A. No, this whole filter circuit, including this resistance branch that you have talked about actually operates so as to stabilize the amplifier itself, and removes any tendency, or a tendency that the amplifier might have to oscillate. Let me [475] say that another way: I stated before that you could take an amplifier and adjust, or maladjust it, if you wish, so it would oscillate, and no longer would be an amplifier, but would oscillate. That is true of any amplifier. Now, if the amplifier without the filter were so adjusted then by putting in the filter you might actually stabilize the amplifier and prevent it from oscillating, the filter circuit itself does nothing to increase any tendency, if you want to use that word, that the amplifier might have to oscillate.

Q. I refer you to the description there which appears on page 13 of Exhibit 11-C, and to that paragraph which starts about half way down the page. Will you explain what is described by that, if, as you say, the circuit which is shown behind page 13 is such that the amplifier-filter combination would have no tendency to oscillate at the frequency for which the filter is set?

(Testimony of Samuel S. MacKeown.)

A. What I said before is still true; the amplifier may be maladjusted in such a way that it will oscillate. You can make that adjustment so bad that it will actually oscillate when the filter is on there. In that case it no longer is an amplifier , and if it does oscillate under those conditions it will oscillate with the frequency determined by the filter circuit; but the filter circuit itself does not increase in any way the tendency to oscillate. That must come from the amplifier, and from some positive feed-back rather than [476] negative feed-back. Negative feed-back always stabilizes the amplifier, and decreases the tendency to oscillate. A positive feed-back increases the tendency to oscillate, so all I can say here is that when the adjustment is made that was discussed here, that may cause the amplifier to oscillate, that adjustment is one which may increase the gain of the amplifier itself so much that the amplifier will become unstable, with or without the filter, and oscillate, due to stray positive feed-back, but this circuit which is shown here is definitely a damping circuit, a negative feed-back, so if anyone removes it, it decreases the tendency to oscillate. That is the property of this circuit.

The Court: What do you mean when you say that an amplifier will oscillate, and not be an amplifier?

A. An amplifier by definition can be made to osciliate.

Q. Oscillation is movement?

A. Oscillation is movement of its own free will.

(Testimony of Samuel S. MacKeown.)

I don't know whether you have ever taken the old telephone transmitter and receiver, which is an amplifier, and have taken the receiver and put it close to the mouthpiece.

The Court: I have many times, when I couldn't get the operator.

A. That is an amplifier, in which you have taken some output from the receiver and put it back into the in put [477] transformer, and have got it so it will oscillate. That is maladjustment of the amplifier. You have put a positive feed-back so there is instability, and the amplifier oscillates by frequencies which will be determined by some natural frequency in the circuit.

Q. Isn't there oscillation in the amplifier?

A. There should be none.

Q. You say oscillation is free movement?

A. Of its own free will. There is nothing needed to start it. It keeps going; what is called a self-excited oscillator. The oscillation in the amplifier means that it is not working right. It is no longer an amplifier; it is an oscillator. It is easy to take an amplifier and make it into an oscillator, as the example I gave you of the telephone receiver and transmitter.

Mr. Mattingly: Q. If the filter-amplifier is set by adjustment of the filter to respond particularly to tubing collar frequencies, then the output of that amplifier, the energy represented by the tubing collar frequencies, would be greater than the energy

(Testimony of Samuel S. MacKeown.)

of the other frequencies which would be fed into the combination, is that right?

A. If we are feeding a whole band of frequencies. What are you feeding in the beginning?

Q. Feeding a whole band of frequencies, including tubing collars. [478]

A. It will amplify that frequency more than any others.

The Court: Let me ask a question to clear it up in my mind: Does a filter have a tendency—I mean, do different filters have different tendencies to catch certain sounds and filter them out?

A. We can build a filter which will transmit certain frequencies, and exclude others.

Q. You can make it richer? A. Yes.

Q. Or you can make one that has a range which you adjust with a button?

A. Or a control.

Mr. Mattingly: Q. Is the statement which I read out of this book, 11-C, pages 13 and 14, a correct statement of the operation of this filter and amplifier set out on drawing 7506, following page 13 of that book?

A. No, it is not—at least, my understanding of this is that it is not correct, in this; if this sentence that you read means that the energy sent back through the filter tends to make the amplifier oscillate, increases the tendency of it to oscillate, that is entirely incorrect. An energy fed back through the filter would decrease any tendency that did exist

(Testimony of Samuel S. MacKeown.)

to oscillate. I did not write this. I am not in any way responsible for what is on this page. [479]

Q. My question is directed to whether or not that is a correct description of what occurs in the arrangement which is shown in the drawing 7506 following page 13.

A. I don't agree with that sentence as I understand the meaning of the sentence to be.

Q. Then you would say that the description given on page 13 is incorrect as a description of the operation of the circuit shown in the drawing 7506?

A. I think it is certainly ambiguous, and I think it gives the wrong impression of the correct one.

The Court: Is that incorrect if you read the previous sentence? It says "In addition to its switching action this control adjusts the amount of energy fed back from the output to input circuits of the amplifier. This energy causes the amplifier to have a tendency to oscillate at the frequency for which the filter is set." Is that correct?

A. No, the last sentence, I am afraid is not correct, because energy which is fed back through the filter—I am reading into that "through the filter" could not increase the tendency to oscillate.

The Court: It is exactly contrary?

A. Yes, it is entirely contrary. There may be other stray paths which could tend to make it oscillate, but that path cannot.

Mr. Mattingly: Q. Would the energy fed back through the path I have just called your attention

(Testimony of Samuel S. MacKeown.)

to through the branch [480] including the 10,000 and 1,000 ohm resistor, and the resistor R-2?

A. No, that energy is so connected that all of that energy fed back stabilizes the amplifier and removes the tendency to oscillate rather than to produce a tendency to oscillate.

Q. Now, refer to page 15 of the instruction book, 11-C, the paragraph beginning at the bottom of that page:

"When it is difficult to get good collars the feed-back control should be set so that when the transducer volume control is set at the maximum necessary for the well the push button will cause the filter to generate oscillations for not over 10 cycles. The filter will give the transducer an overall amplification somewhat greater than normal for singles of the frequency for which the filter is set. The amplification increases as the feed-back is increased. The filter will have a tendency to decrease the sharpness of the fluid, tubing catcher, and liner top breaks on the record and in some cases it will be necessary to record those points on one record without the filter and then use the filter to include the tubing collars on the record."

Is that a correct description of the operation of the circuit as shown on drawing 7506?

A. That may be when you remember that when the transducer [481] volume control is set to a maximum is one condition then the minimum energy is fed back through the filter circuit, and that the volume control on the amplifier may be increased un-

(Testimony of Samuel S. MacKeown.)

der those conditions. In other words, the maximum amplification will come when the energy feed-back is a minimum through the filter circuit, and under that condition this could be a correct statement, particularly if the other control, the volume control, is turned up very high.

The Court: Is that what you mean by decrement?

A. Decrement is decrease in the giving off of energy.

Q. The left hand control frequency is calibrated from 1 to 1,000. That does not regulate anything, does it, the frequency control?

A. The frequency control regulates the frequency which the amplifier will selectively amplify.

Q. What is a transducer?

A. A transducer is a very general term for, let us say, any box in which you put current on one side and get a current which is related to it, out of the other side. It is a very general term. It might be an amplifier; it might be a filter; but it is a very general term, which would include a filter or amplifier.

Q. All right. Now, when the switch is off the filter is entirely disconnected from the transducer. I take it that the transducer is the thing that takes the electric energy [482] through it to the filter?

A. Right through to the recorder. It includes both filter and amplifier.

Q. Then all the transducer is used, in a sense, as the whole electrical apparatus?

(Testimony of Samuel S. MacKeown.)

A. Yes, everything except say, the microphone.

Mr. Mattingly: And recorder.

A. And recorder. The microphone would connect to the input of the transducer, and the recorder would connect to the output of the transducer.

The Court: Could an amplifier be said to oscillate, if it responds to a certain beat, whether that is provided by sound or electric energy, which beat is received at a regular interval? A. No.

Q. Could that be said to be an oscillation of an amplifier?

A. No. If an amplifier responds to its input it is not oscillating. When it is oscillating it is giving out something that has no resemblance to anything that goes in at the input. It is no longer an amplifier.

Q. I understand how you change oscillation, but what I want to know is the effect of oscillation on amplification.

A. It destroys it. It absolutely destroys it.

Q. You mean you get no sound out of the amplifier?

A. No; I mean you get no sound that corresponds at all [483] with what you are trying to amplify.

Q. In other words, you couldn't set that machine to oscillate at the tubing collars?

A. Well, I could if I went inside the machine and changed it around; yes.

Q. Then it can be adjusted so that it would faithfully record the tubing collars by oscillating?

(Testimony of Samuel S. MacKeown.)

A. But it would record them whether they were there or not. I would record them in this room, whether tubing collars were there or not.

The Court: It would?

A. Yes. If you go back to the telephone, if you take that receiver and put it near the transmitter, if you try to talk into the transmitter a person couldn't hear what you said, because the other noise entirely masks it. The noise of its oscillation entirely masks it.

Q. And if you set that machine to operate at regular intervals upon the the introduction of sound or electric impulse, all there would be is the oscillation, and you would have to know in advance at what intervals you would want it to oscillate?

A. If would always give me, and it would give me in this room, if I set it up to oscillate at that frequency, although there may not be tubing collars within miles of here, it would keep on oscillating at that frequency as long as I had a battery supplying power to it; and the kick I would get would have [484] absolutely no relationship to any tubing collars. If I changed the distance between tubing collars I wouldn't change the record, at all, that I would get.

Q. They would be the same?

A. Each one of those would be exactly the same size, and continue indefinitely; and it would do that whether I put a pressure impulse in the well or didn't put a pressure impulse in the well.

(Testimony of Samuel S. MacKeown.)

Q. And that oscillograph which was taken—that would be an oscillograph, wouldn't it?

A. It would be an oscillator.

Q. That could be used to measure the lapse of time, couldn't it.

A. It could be, very beautifully. That is what your watch is. Your watch is an oscillator, but it couldn't be used to measure tubing collars.

Q. Not the lapse of time between echoes?

A. No. Those wouldn't affect it, at all.

Mr. Mattingly: Q. I will refer you to page 14 of this exhibit 11-C, which describes the way in which the filter is calibrated for frequency. Beginning at the top of the page:

"Before operating the filter it should be calibrated for frequency. The most convenient calibration curve is one of filter setting vs. record length of a cycle of the filter [485] frequency. This calibration may be made in the field by setting the feed-back control (Decrement) so that the amplifier oscillates for about 10 cycles after pushing the test button with the volume control set at about 75-Hi."——

The Court: What does that mean, 75-Hi?

A. There are two switches, one high and one low.

The Court: I see.

A. They work the volume control.

The Court: That means "high", then?

A. Yes.

Mr. Mattingly: Q. (continuing) "Records should be made of the oscillations at 10 or more different

(Testimony of Samuel S. MacKeown.)

frequency settings and the average length of cycle for each setting (taking an average of 10 or more cycles) should be plotted against filter setting."

From that description would you say that the setting of this decrement control to a certain value, and then the mere touching of the button to give the impulse into the amplifier-filter circuit, would cause the amplifier to oscillate for 10 cycles and then stop?

A. The amplifier would give you those oscillations for 10 cycles or more, but it would not be what I have defined as an oscillator.

Q. If the decrement were set at that same value and you [486] received a series of 10 tubing collar echoes at that same frequency for which you had set the filter, wouldn't the amplifier operate to amplify those tubing collar frequencies?

A. Yes.

Q. And with the filter set at that same value that we have spoken of in the last few questions, wouldn't the filter then have a natural period of oscillation corresponding to the frequency of the tubing collar echoes?

A. Yes, it would.

The Court: What you mean is that it can be set so that it oscillates and records the tubing collar echoes?

A. Well, maybe I can explain. Let's think of a pendulum in a grandfather's clock. That pendulum is not oscillating, but it has a perfectly natural frequency of oscillation because of its length, and if it starts oscillating, it will oscillate with that fre-

(Testimony of Samuel S. MacKeown.)

quency. I think what Mr. Mattingly asked in his last question: It is a pendulum not moving, but it has a natural frequency of oscillation because of the structure, and if it does oscillate it will oscillate at the natural frequency.

Mr. Mattingly: Q. Dr. Mackeown, I think on your direct examination you stated that patent 2,156,519 was directed to the use of a pressure impulse? A. Yes.

Q. Do I understand your testimony to mean that that [487] patent is directed to the use of the pressure impulse created only by the injection of a slug of gas from the pressure chamber shown in the Walker patent 2,156,519?

A. I think this patent discloses the use of a pressure impulse, which can be nicely adjusted as to its magnitude and other characteristics. There are six places in the patent which describe the pressure impulse or its manner of response. Those places are page 3, column 1, at line 22; page 4, column 1, at line 35; page 4, column 1, at line 63; page 4, column 2 at line 42; page 4, column 2, at line 71, and page 5, column 1, at line 29. All of these places refer to the necessity, as I understand it, or certainly the desirability of being able to adjust this pressure impulse to obtain the desired record and the necessity of doing that, and, I think, as I understand the patent, an impulse chamber or some like device in which the pressure can be accurately adjusted to give the desired characteristics.

(Testimony of Samuel S. MacKeown.)

Q. You did not mean, then, by your statement, that the patent is directed to or limited to the use of the pressure impulse, that the patent excludes the use of a gun shot, did you?

A. I think it does. For instance, Mr. Mattingly, let's take several of these references. Let's take the one on page 3, column 1, at line 22:

"The only item which must be provided for is that of [488] producing a pressure wave echo of such magnitude and such character that the echo from the tubing catcher can be distinguished from the echo received from the fluid surface."

Q. What part of that statement that you have just read excludes the use of a gunshot?

A. I don't see how you can change the magnitude and character of a gunshot to give any desired changes that may be required. I think if you fire a shot you are stuck with whatever pressure impulse that shot gives, and you have not any ability to change the impulse that you get. There are a good many other places, as I have mentioned, where I think that is brought out even better—the desirability of being able to regulate the pressure impulse that is used. Let me refer, for instance, to the patent at page 4, column 2, at line 42, which states:

"Thus by observing the effects of a series of pressure impulses of different intensity or pressure, the operator may determine which impulse is most desirable to produce the distinctly recognizable and differentiatable peaks *c* and *d*, allowing him to dif-

(Testimony of Samuel S. MacKeown.)

ferentiate between echo from the tubing catcher and the echo from the fluid surface."

There I think it does require this adjustment that I was speaking of.

Q. Now, Dr. Mackeown, do you know whether or not the [489] defendant in its practice always uses the same size of shotgun shell or same size of cartridge in producing the pressure impulse used by the defendant?

A. I don't know, but I understand it does not use the same size shell.

Q. Isn't it true that they use in some instances a 10-gauge shotgun shell and in the other instances use a .38 caliber pistol shell, and in the instance used in the court room here a .22 caliber shell?

A. I understand in practice that they use either a No. 10 shotgun shell or a No. .38 cartridge.

Q. And each of those different shells would produce a pressure impulse differing in magnitude from the other; is that correct?

A. Each one would produce a different impulse; that is correct.

Q. Then the shells of one or another of those cartridges would constitute a selection of the magnitude of the impulse, would it not?

A. I don't think so. By that I mean, Mr. Mattingly, that with the defendant's apparatus there is no necessity of selecting any impulse of particular magnitude. The magnitude of the impulse can be compensated for by the change of the setting of your amplifier. And the defendant's apparatus is

(Testimony of Samuel S. MacKeown.)

not capable [490] of differentiating between a positive and negative pressure impulse. I understand, again, the No. 10 shell is suitable for all work. I understand they don't use it for shallow wells for two reasons: The .38 blank is a little cheaper, but more important than that, there is less smoke coming up to the microphone and the parts inside by the .38 blank than there is from the No. 10.

Q. That is your understanding. Have you been told that by the defendant and employees of the defendant?

A. I have been told that by the defendant, and it seems reasonable to me.

Q. Do you know whether or not there are conditions existing in these wells, which are tested by the defendant, under which the firing of the 10-gauge shotgun shell will produce a record which is mangled up by reverberation noises and hash resulting from the firing of the 10-gauge shotgun shell?

A. All I can say is what theory would indicate, if that is what you wish. Theory would indicate that assuming we have a fairly rigid structure, such as any tubing and casing, then the magnitude of your impulse would not increase or decrease in any way the reverberations, the per cent of reverberations. In other words, what we might call the ratio of a signal to noise, the desired signal to reverberations, or other things produced by the impulse, should be independent of the magnitude [491] of the impulse. Your disturbances would be proportional to the impulse. And I would expect that there would be no differ-

(Testimony of Samuel S. MacKeown.)

ence in the gas in the pipe, the thing received by the pressure diaphragm or the microphone, there would be no difference in the ratio of signal to disturbance as you change the magnitude of the impulse.

Q. You have never actually used the defendant's apparatus in making commercial tests in oil wells, have you?

A. No, I have never used it in making commercial tests.

Q. The condition, such as I assumed in my previous question to you, could exist, could it not?

A. It could. And I could say this: That at Duncan we made a whole series of tests where we changed the impulse, using an impulse chamber from some 10 pounds to over 100 in exactly the same well. Everything else kept constant, and I don't believe you could tell one record from the other. The amplifier was changed each time. I think you will find the same ratio of signal to noise, signal to disturbance, on each one.

Q. But all those tests were conducted on one well; is that right?

A. That is right.

The Court: As I understand, the use of the amplifier eliminates any necessity for delivering a larger or smaller pressure impulse in a well according to its depth or size? A. Yes. [492]

Q. In other words, if the implse is slight the amplifier can pick it up, and if it is greater it can diminish it?

(Testimony of Samuel S. MacKeown.)

A. That is right, with a single exception: It should be large enough so that it will keep other noises, such as pump noises or other things relatively small.

Q. It should be greater than——

A. Than outside disturbances. As long as it is big enough there is no need of cutting it down, and that is all you need.

Q. I see. Is there any reverberation that comes back and forth across the well as it is going down in the pipe?

A. They would die out quickly. In the beginning there might be, but as you go down a short distance they will be what we say damped out very quickly and they will be absorbed by the repeated reflections back and forth.

Mr. Mattingly: Q. I refer you to the plaintiff's patent, 2,209,944, and call your attention to claim 7 of that patent. That claim is directed to the selection of the magnitude of the impulse which is to be used; is that correct?

A. It is directed to even more than that. It is directed to first making a series of tests, and from that series of tests picking out the impulse which will give you the desired results.

Q. Now, do you find any statement in any of the other claims of that patent which are limited to the magnitude of the impulse? [493]

A. Yes, I think I do. Claim 3, for instance. May I read the part——

Q. Yes. A. The first part.

(Testimony of Samuel S. MacKeown.)

"The method of determining the unknown loc tion of an obstruction in a well having a string tubing therein, which consists in creating an accou tical impulse in the annular space between the tu ing and the well casing of such magnitude as co pared with the depth of the well and the resistan to pressure wave transmission therethrough as w produce echoes from portions"—and so fo th.

That part I have read, I think, requires the s lection of an impulse of proper magnitude. An I think most of the claims actually do call for ju such a kind of an impulse."

Q. Will you please point out where, in eith of the claims you find any such statement?

A. In claim 2 it states: "which consists in crea ing an accoustical impulse in the annular space b tween the tubing and the well casing to produ echoes from portions of the tubing string disti guishable from each other and from the echo fro the unknown obstruction,"

I think the requirement there that the accoust cal impulse is to produce these distinguishab echoes requires, in view of what the teachings the patent are, that the impulse be adjusted to th proper magnitude and character to do that. [49

Q. That does not say that in that claim, thoug does it?

A. I think it says it. As I understand, the a coustical impulse is to produce these distinguish able echoes, and the patent tells you how to d

(Testimony of Samuel S. MacKeown.)

that; that you must adjust the pressure impulse to do that.

Q. I believe you stated that in defendant's apparatus there is nothing which will produce distinguishable echoes, is that correct?

A. I thought I said there was nothing which will register the distinguishable echoes.

Q. Doesn't the defendant's apparatus produce echoes which are readily possible to distinguish between fluid level echoes and echoes in the tubing collars?

A. Not as I understand the claim there, but any character- [495] istic of a single wiggle itself.

Q. Do you find anything in this claim which specifies the characteristic of the wiggle?

A. I think so.

Q. Point it out.

A. "to produce echoes from portions of the tubing string distinguishable from each other and from the echo from the unknown obstruction."

Now, the echoes themselves, each by itself, is, I understand this to mean, distinguishable in its characteristic from the other; not in its location along the well, but in its characteristic.

Q. Will you find any place in the specification of the patent where "distinguishable" is used in the sense that it has to be a characteristic of the wiggle; that is, whether or not it is a positive or negative wiggle?

A. Yes, I think there are just such places, Mr. Mattingly.

(Testimony of Samuel S. MacKeown.)

Q. Patent 2,209,944 we are referring to now?

A. Yes.

I have found my references, Mr. Mattingly, this 2,209,944 patent that I think teach that t pressure impulse should be adjusted to give th distinguishable echo; that is, so that the echo i self can be used to identify whether you have tubing catcher, fluid level, or some other type obstruction.

Q. That I don't believe was the question whi I asked [496] you. Mr. Reporter, will you read t question to the witness?

(Question read by the reporter.)

A. Let me refer to page 4, column 2 at line 2 which reads:

"Thus by observing the effects of a series pressure impulses of different intensity or pre sure, the operator may determine which impulse most desirable to produce the distinctly recogni able and differentiable peaks *c* and *d*, allowing hi to differentiate between echo from the tubing cat er (or such other obstructions as may be know to be in the well) and the echo from the flu surface."

Q. Where does that mention anything about t positive or negative wiggle?

A. It describes the echoes arriving from t different obstructions as distinctly recognizable a differentiable, and to me means that they have characteristic which allows you to distinguish

(Testimony of Samuel S. MacKeown.)

the characteristic the type of obstruction which is causing those echoes.

Q. And you think that that characteristic that you have referred to is that it must be a positive or negative wiggle in the line?

A. I think that is one of the characteristics; there may be more. In other words, if we have a tubing catcher with a pressure responsive device then you do get a positive pressure wave when you hit the top of that tubing catcher, and a negative pressure or rarefaction wave when you leave the bottom of that catcher. Now, they can get a distinguishable characteristic on a pressure responsive device which cannot be obtained when you use a device like the hot wire microphone, which cannot distinguish between a pressure and rarefaction wave. [497]

Q. Then the thing which distinguishes, as you have used the word "distinguish" is whether or not there is a diaphragm or a hot wire microphone used to receive and record the echoes?

A. As I understand the patent there are two things to get that. One is that the recorder be a pressure response device, such as can have that property, and, in addition, that the pressure impulse be adjusted to the right magnitude to give that kind of echo.

Q. Now, will you tell us under what condition can the pressure impulse be so adjusted as not to produce on a diaphragm type of instrument the negative and positive wiggle?

(Testimony of Samuel S. MacKeown.)

A. I don't know. I did not write the patent. That's what the patent says.

Q. On the records which are produced by the defendant, can you distinguish between tubing collar echoes and tubing catcher echoes?

A. You can, yes. You can, simply because the magnitude of the tubing collars is smaller in general than the magnitude of the tubing catchers or fluid surface, but there is no characteristic wiggle, let me say, or shape of the wave that allows that.

Q. I believe you stated also that the defendant's apparatus does not measure the time between the injection of the [498] shot into the well and the receipt of the echoes from the various obstructions back from the well.

A. That is true, as I understand their method.

Q. Do I understand by that that you mean that the defendant's recorder does not record the lapse of time between the creation of the impulse and the receipt back of the echoes?

A. That is correct, and no calculation or determination of the lapse of time is made.

Q. Do you understand how the defendant's recorder operates? A. Yes.

Q. What causes the movement of the paper lengthwise through the defendant's recorder?

A. A small motor.

Q. And is that small motor driven at a constant speed? A. Yes.

Q. Is there any means provided in the defend-

(Testimony of Samuel S. MacKeown.)

ant's recorder for making that tape move at constant speed? A. Yes.

Q. Then in a given interval of time, say, one second, there will be precisely so many inches of that tape moved past the pen, will there not?

A. That is true.

Q. When you say this does not measure time, or record time, do you mean that it does not record the time in units of minutes [499] or seconds or hours?

A. It does not record the time. That paper, I don't know how fast it moves. I know it moves at a constant rate, but I do not know how many inches it moves per minute. I understand their operators do not know, they don't have to know, and they don't care. You can make a calibration and use it for measuring time, but it is not done.

Q. In the defendant's apparatus, the feed of that paper is so many inches past the pen in a given interval of time?

A. Yes, that is true, and that is a constant speed.

Q. The space of those wiggles along the chart on a constantly moving paper represents the time interval at which the echoes are received back at the ground surface, does it not?

A. Yes, in an unknown unit, if you wish.

Q. And the measure of time does not necessarily have to be in a known unit, does it?

A. I think so. For instance, I can't tell you by looking at any one of these charts what the time is

(Testimony of Samuel S. MacKeown.)

between any two marks on it, because I don't know what the speed is.

Q. By that you mean that you don't know the time in units of seconds or tenths of seconds?

A. Or any unit of time.

The Court: The way they determine that is knowing the tubing lengths?

A. That's the way it is determined, by comparing the known [500] distance rather than the time.

Mr. Mattingly: Q. Then the distance along the tape made by the defendant between the shot, for example, and the echo from the tubing catcher, represents the lapse of time between the shot and the time the echo came back from the tubing catcher?

A. It can represent the lapse of time in arbitrary unknown units.

Q. Throughout the trial of this case I believe you and various other witnesses have referred to the slope of the line on these various charts that we have referred to, and just for the purpose of the record, the slope of that line is a graphic representation of a fraction is it not?

The Court: Why don't you just leave it "slope"? I know what a slope is, but I don't know what a graphic representation of a fraction is.

The Witness: I don't either.

The Court: As I understand it, it is carrying out the condition based upon two or three known factors, or two known factors, rather; you have pressure and depth at two different places or three, and all you do is to assume that they are the same and carry them out?

(Testimony of Samuel S. MacKeown.)

A. That is correct.

Q. That is what they call extrapolation?

A. Yes.

Q. That is ordinate and abscissa? [501]

A. When you extend any experimental result by graphical or other method beyond the range which those experimental results have taken, that is called extrapolation.

Q. In other words, beyond the known range?

A. Yes, that's right.

Q. Sometimes you refer to that as a curve, even though it may be straight?

A. Yes, because when we plot, using ordinate and abscissa, we often get a line which is not a straight line but a curve. In general, we speak of a curve there which may be a straight line.

Mr. Mattingly: Q. I have here a book on plane analytic geometry, and I refer you to page 28 of that book.

Mr. Graham: Who is that book by, and when was it published?

Mr. Mattingly: The book is by Harding and Mullins, and was published in 1937 by MacMillan Company.

The Court: What is it, a standard text book of some kind?

The Witness: Yes, it is a plane analytical geometry.

Mr. Mattingly: Q. The statement is made on page 28 of that book that the slope of the line represents an equation——

(Testimony of Samuel S. MacKeown.)

Mr. Graham: Let us have the words there from the book, if you don't mind.

Mr. Mattingly: Represents an equation in which the value of the slope equals $\frac{Y_1 - Y_2}{X_1 - X_2}$, is that correct?

A. That is correct, where Y_1 and X_1 represent the ordinate and abscissa at one point in the curve, and Y_2 and X_2 represent the [502] ordinate and abscissa on any other point of the curve.

Q. And as represented on the chart shown in patent 21,383, the slope of the line represents——

The Court: The slope of the extrapolated line?

Mr. Mattingly: The slope of the line prior to extropolation, that is, the part of the line which connects the several points that are actually measured, that slope represents the difference in two pressures; that is, we can say that the pressure is represented by Y—that would be $Y_1 - Y_2$ over the difference in the height of the fluid level, which we might call X, and represent that by $X_1 - X_2$, is that correct?

A. That is correct.

Mr. Graham: Let it appear in the record that counsel has been referring to Figue 3, in patent 21,383 in suit; that is the reissue patent.

The Court: All right.

Mr. Mattingly: One more point, Dr. Mackeown. In your testimony you were asked whether or not the defendant determines the density in its operations. I believe you stated that the defendant did not determine density, and you continued your answer that the defendant did not calculate the density. Now,

(Testimony of Samuel S. MacKeown.)

do you draw any distinction between the word "determine" and the word "calculate"?

A. No, I did not mean that. They don't in any way find the density. They don't know what the density is, either by calculation or measurement, or combination of the two. [503]

Redirect Examination

Mr. Graham: Q. Doctor, will you make a short, consice statement of the effect of the filter-amplifier combination as used in the defendant's device?

A. The filter-amplifier combination in defendant's [504] apparatus, is a piece of equipment which can be tested to selectively amplify the echoes in the tubing collars. Neither the amplifier nor the filter contain a tuned circuit or a resonant circuit. And the selective amplification is obtained by having the filter control the gain of the amplifier.

Mr. Graham: Your Honor, we have had this defendant's apparatus in court and, also, the pieces of apparatus that were used in Duncan in making the experiments in the Wyatt and Lehr patent. We would like to have those removed. One of our men has been here a couple of times to take them away, but counsel has said he might want them for something or other.

The Court: Do you now wish them?

Mr. Mattingly: I don't believe so, your Honor. If the defendant is willing to stipulate that the commercial apparatus, which has been used by the defendant prior to the manufacture of the device in court, is exactly the same as the device which is in Court——

(Testimony of Samuel S. MacKeown.)

The Court: What is that?

Mr. Mattingly: The defendant in this case has used two different pieces of apparatus—two different types of apparatus.

The Court: Well, he used the Wyatt and Lehr experimental apparatus. Is that what you mean?

Mr. Mattingly: No; I mean in their commercial operations, the defendants have used, as defendant's apparatus, two different types of apparatus. One of those was the kind of apparatus in [505] which the recorder was in a separate box from what they have termed the transducer, whereas, in the piece of apparatus which is in court here the transducer and recorder are all in one box.

Mr. Graham: Well, is that material?

Mr. Mattingly: I only want to know whether or not the defendant is willing to stipulate that, in so far as this case is concerned, both those types of apparatus are the same.

The Court: That is, that they are identical but housed differently?

Mr. Graham: One is in one box and the other is in two boxes.

Mr. Babcock: They aren't absolutely identical. I know one change was made in the recorder.

Mr. Mattingly: But as far as affecting the purpose of this case?

Mr. Babcock: As far as affecting the purposes of this case I think we can stipulate.

Mr. Mattingly. That is all right. Then, I have no reason to ask the defendant to keep the apparatus in court. [506]

HOWARD C. PYLE

a witness for the defendant, testified as follows:

My address is 617 West Seventh Street, Los Angeles, California. I am employed by the Union Oil Company of California as their chief production engineer. With the exception of a little over a year during 1932 and part of 1933, I have been with the Union Oil Company since January of 1927. I have a degree of Bachelor of Science from the University of California, in petroleum engineering, college of mining; degree of Master of Science from the University of Southern California, and a degree of Petroleum Engineer from the University of Southern California. I am a member of Sigma Xi and Beta Tau; the American Institute of Mining and Metallurgical Engineers; American Association of Petroleum Geologists; American Petroleum Institute. I am familiar in general with the Depthograph and Echo-Meter, and the uses to which they are put in the oil fields. The Union Oil Company uses both the Depthograph Company, and the Halliburton Oil Well Cementing Company, which operates the Echo-Meter. I have been familiar with the Depthograph and the Echo-Meter very generally since commercial work started with both of those. I am not sure as to the exact dates, but I would think it would be 1935 or 1936, approximately.

Mr. Babcock: Q. Did the Union Oil Company itself ever use any sonic methods to locate fluid levels?

A. I am not specifically familiar with their early

(Testimony of Howard C. Pyle.)

work, [507] though I have talked with the people who did the first work.

Q. When did you first get any knowledge that anything had ever been done by Union?

A. In the year 1935 or 1936 I had occasion to talk to several of the people who worked with the methods of 1927 and 1928, I believe, and had occasion to read the files that were available to our company on the subject.

Mr. Babcock: I will ask that these documents be marked for identification; first a drawing which bears date April 6, 1928, Union Oil Company of California, drawing No. RDS 176, and ask that that be marked defendant's exhibit P. All of these are photostats, by the way. The next is a photostat of a sheet which bears the heading: Determination of the oil levels in wells by sound signals; and it is signed Edson R. Walcott, May 16, 1927; that will be P-1.

The next is a four-sheet document. It is in the form of a letter on Union Oil Company of California stationery, dated April 6, 1928, to Philip Subkow, patent engineer, and signed in typewriting W. A. Raine, manager research and development, by E. R. Walcott. That will be P-2.

Q. I hand you these documents, marked P, P-1 and P-2, and ask if you can identify them.

A. I can identify them as being on Union Oil Company stationery. I am familiar with the signature of Mr. Walcott, [508] and one of the witnesses, P. H. Jones.

(Testimony of Howard C. Pyle.)

Q. When did you first see these documents or the originals from which these were photostated?

A. I am confident that these were in the Union Oil Company's patent department and research and development files when I examined those files probably in 1935 and 1936. I am not sure of the date. I am familiar generally with the work these men did, as a result of an examination of the files and with talking with some of the men.

Q. I understand, then, that in 1935, or at about that time, you learned that the Union Oil Company had done some work on the use of sound to locate fluid levels?

A. That is right.

Q. Can you state briefly what it was you learned they had done at that time? Was that the first you knew that they had done anything along this line?

A. Yes; as well as I remember it is. Back in 1926 or '27 Mr. Rubel, presently vice-president of the Union Oil Company, and at that time an engineer at one of the Union Oil Company oil fields, the Dominguez oil field, did some experimental work in the determination of fluid levels in oil wells. I am familiar with this through his own accounts to me. And it was these accounts of his that caused me to look through the files of the company to become more acquainted with the work that followed [509] this earliest work of Mr. Rubel.

Mr. Mattingly: Your Honor, I must object to the witness testifying here as to what work was done

(Testimony of Howard C. Pyle.)

by the Union Oil Company, since he has learned it only by hearsay.

The Court: Your objection is good.

Mr. Mattingly: He may testify as to what knows.

Mr. Babcock: Yes, that is what I meant to bri out, your Honor, what he learned in 1935; what knowledge was in 1935.

The Court: Well, counsel is objecting to h learning from somebody else that somebody else some work in 1927.

Mr. Babcock: Yes.

The Court: Well, proceed.

A. I think I have recounted it. I merely talk to the men, most particularly with Mr. Rubel, abo that early work, and read the files. I had no fi hand acquaintainship and was not in the part of t country during that period of time, although I w in the employ of The Union Oil Company.

Mr. Babcock: Q. Let's start from 1935. Gi the historical development in the Union Oil Co pany, if there was any development in the sou methods for locating fluid levels, to which you have direct knowledge and in which you took pa

A. Well, Mr. Rubel, as I said, acquainted m with the early work that he had done and told m that he had discussed [510] this work with Dr. J kosky; that Dr. Jakosky was much interested in and asked me to cooperate with Dr. Jakosky in t event that he chose and decided to become active the development of oil field tools or equipment f

(Testimony of Howard C. Pyle.)

the measurement of fluid levels. I had known Dr. Jakosky before. Dr. Jakosky developed the instrument that is referred to as the Echo-Meter, and the Union Oil Company provided wells on which the instrument could be checked during the period of development.

Q. Did you take any part in that development?

A. No. I was just generally familiar with it; and the development and the testing of the equipment proceeded in the field and was conducted, as far as Union Oil Company personnel were concerned, by engineers who were under my direction at the time.

Q. Why were you or the other engineers of the Union Oil Company interested in developing a sound method of measuring fluid levels or in seeing such development?

A. Well, we had long been interested in the development of bottom hole pressures as a guide to the determination of production performance of oil wells, and we found that in many cases, particularly as regards to pumping wells, that the pressure and measuring equipment was not only expensive, but had a high maintenance cost and we were interested in any means of accomplishing the end of pressure measurement [511] economically for a lesser cost than by pressure gauges.

Q. I gather, then, that prior to 1935 you had done some work with pressure gauges?

A. Yes, that is right. We had become interested in bottom hole measurements in 1933, and our first

(Testimony of Howard C. Pyle.)

work in that connection was, if I remember rightly in December of 1933. I am quite sure of that date That work was first in connection with the measurement of pressure under known producing conditions in oil wells. Subsequently the work expanded to the measurement of pressure while wells were producing; both first for flowing wells and later for pumping wells.

Q. Where was that work?

A. Well, the first work that the Union Oil Company did was, I believe, in their Stearns property in the LaBrea-Linda district. The first extensive use in California of pressure methods as a means of determining the productivity of a well was a cooperative effort in the Kettleman-North Dome field made at the request of the N.R.A. That was in 1935. The various operators in the state by that time had, almost without exception, become interested in bottom hole pressures and measurements and in a cooperative way they joined forces and measured the productivity of all the wells in the field. If I remember rightly, there were approximately 200 wells there at that time.

The Court: Were those flowing wells? [512]

A. Yes.

Q. How were they measured?

A. With a bottom hole pressure gauge.

Q. How did you lower it?

A. On a wire line. I personally took part in that. The work was conducted through a committee. I don't just recall now whether it was appointed by

(Testimony of Howard C. Pyle.)

the Central Committee of California Oil Producers or by the representative of the N.R.A. I was on that Committee and participated both in the outline of the work and made frequent visits to the field to observe the conduct of the work.

Mr. Babcock: Q. Does the Union Oil Company still today use a pressure gauge or a pressure recorder to record bottom hole pressures?

A. Yes, we do a great deal of work in that connection. We have a small group who devote their time exclusively to that type of work.

Q. Which is the more accurate way of determining bottom hole pressures, a pressure recorder or these instruments which use the sound or pressure impulse such as a Depthograph or Echo-Meter that measure fluid levels?

A. In my opinion the pressure gauge is the most accurate known method of measuring the bottom hole pressure.

Q. Are there any others besides a pressure recorder or a [513] Depthograph or Echo-Meter for determining bottom hole pressures?

A. I think so. There are a number of methods that have been used for determining pressures in oil wells. The earliest methods were done crudely by lowering a bailer in the well for determining where the fluid level started in the well. Subsequently pressure bombs were used. They were not of the recording type, but were merely closed bailers with a check valve in the bottom. They were lowered into the well and then brought to the surface and they would

(Testimony of Howard C. Pyle.)

attach an ordinary surface gauge to it and measure the pressure; that is, there were subsurface pressure gauges which we used, which are wholly self-contained. There was an early method developed of lowering hollow tubing, and finding the pressure required to inject gas out of the bottom of the tube, which was directly related to the pressure. Then, there are these fluid level methods for determining the fluid level in wells, which can be related to the early work of lowering a bailer into the well.

The Court: You mean compared to the early work? A. Yes.

Mr. Babcock: Q. By early work, what dates do you have reference to?

A. I am distinctly not an old timer in the business. I know that the measurement of pressures by determining fluid levels with a bailer was discussed in 1925, when I was in college, and I associate it with a very much earlier date [514] than that. I have known that the bottom hole pressure could be calculated from a determination of the fluid level since 1935 or 1936.

Q. Are you familiar with what is called the Dice's formula for calculating the weight of a column of gas? A. Yes, sir, I am.

The Court: Let me see if I understand you. In 1925 you knew that you could determine bottom hole pressure by determining the height of the fluid level in the well, did you? A. Yes, sir.

Q. How would you do it?

A. The well's productivity is related to the pres-

(Testimony of Howard C. Pyle.)

sure opposite the producing formation, and pressure is expressed by the amount of back pressure, one might call it, against the formation, and that is determined, and varies with the fluid level.

Q. In the well?

A. Yes, sir. It is the measurement of this fluid level in the well, or the determination of whether or not there is fluid in the well, which preceded and prompted the development of sub-surface pressure gauges.

Q. If you can determine the pressure, the bottom hole pressure from the fluid level, why was it necessary to have a pressure gauge? Why didn't you just put a plumb down there and measure to the top of the fluid level? [515]

A. The answer to that, your Honor, is that the earliest measurement of fluid level by bailer is confined, and was confined wholly to wells without surface pressure. In other words, the well was just opened so that the bailer could be run in; and the work has been extended and interest has centered about wells of greater productivity. There was considerable surface pressure, and means had to be provided to get a pressure instrument that works or measures in wells that had to be closed in to confine the gas in the well under pressure.

Q. Why didn't you run pumping rods down the well?

A. Very seldom do they run pumping rods into wells with pressure. It can be done, and is done.

Q. They don't pump?

(Testimony of Howard C. Pyle.)

A. There is no surface pumping. The well is open. We are interested in the so-called measurement of pressure in flush wells or flowing wells. In all these wells you cannot open up the surface of the wells without the wells flowing.

Q. How do you use the bailer?

A. We run that in what we call a lubricator.

Q. Why couldn't you run in any other instrument, such as a plumb bob, or a wire?

A. You could.

Q. Can't you just put an instrument in there, a piece of lead? [516]

A. And feel the fluid level?

Q. Yes.

A. That would be very difficult, for one thing, in order to avoid leakage. You have so much friction on your line, your wire is not straight, so the line would hang on the side, you lose sensitivity, and you can't distinguish.

Q. Don't you do that with a piano wire in a depth pressure recorder?

A. No; the recording of pressure by fluid level is incidental to that.

Q. Doesn't the wire get stuck?

A. It doesn't get stuck, but you lose sensitivity. It is very difficult with a pressure gauge to identify the position of the fluid level as you run into the well.

Q. I understood a while ago, you to say you knew you could determine bottom hole pressure from the

(Testimony of Howard C. Pyle.)

fluid level, since 1935; now you say that you knew that since 1925.

A. There is a distinction, your Honor. I may say that I knew we could determine fluid level as early as 1925, in that I had felt that that was nothing new at that time, but my interest and my understanding of the matter did not go beyond the fact that that was a fluid level and that was that. In 1935 was when I knew—1935 and 1936 was when I knew that you could determine bottom hole pressure by fluid levels. [517]

The Court: I understand, but you can't do it without any variables and just from one measurement? A. You can approximate it.

Q. How would you approximate it, for example, a hundred barrels a day, 100 pounds pressure at the casing head, 3000 feet to the surface and a 5000 foot hole?

A. Well, you would start by adding the pressure in the casing of the well. At the top you have a hundred pounds. Of course, you would have a 3000 foot column of gas. You would evaluate the weight of that column of gas. That can be done by calculation. So you would have a 2000 foot column of oil and you would calculate the weight of that column of oil.

Q. Do you know that it is oil?

A. Well, I qualify my answer. Under some conditions you could approximate it.

Q. All right. We will assume it is oil.

(Testimony of Howard C. Pyle.)

A. All right. Then, do you want to know the variables that would influence that?

Q. Yes, if there are any. I am asking. I don't know.

A. Your Honor, you can approximate the bottom hole pressures. It is commonly done.

Q. Well, let's see. You take the 100 pounds pressure on the casing head? A. Yes.

Q. And you add to that the weight of the column of gas [518] 3000 feet high?

A. Say that would be 20 pounds.

Q. 20 pounds. Then you have got a pressure of 120 pounds at the fluid level? A. Yes, sir.

Q. All right. And you have 2000 feet of oil?

A. Yes.

Q. And you know what that weighs. What is that?

A. Well, 35 pounds per hundred feet, or 30 pounds.

Q. So you multiply 2000 by 35. That would be 700 pounds. That would be 820 pounds?

A. Yes, sir.

Q. Is that what you would approximate the bottom hole pressure at. Would you make any allowance for the gravity of the oil?

A. The allowance for the gravity of the oil, the amount of water that came up in the oil—well, we assumed it was all oil—the effect of the temperature on that oil, were all made in the 35 pounds per 100 feet.

Q. That is all in there? A. Yes.

(Testimony of Howard C. Pyle.)

Q. So, having those factors you would say that the bottom hole pressure would be approximately 820 pounds? A. Yes, sir. [519]

Mr. Babcock: Q. In this 2000 foot column of oil that you have just been discussing, in its assumed condition in an ordinary well, or in the average well, I might say, is the density or gravity of that column of oil likely to be constant?

A. Well, we are sort of compounding a whole series of estimates and assumptions here. And to answer that I would have to further qualify the thing. The first thing, one would almost have to make this under a spot determination, and it depends upon whether gas is coming up through the oil in appreciable quantities, and it would depend upon whether there was water mixed with the oil and is itself heterogeneous or stratified. And if you want me to make those qualifying comments on it I will try and answer the question.

Q. Well, what is your opinion as to whether the density in this assumed well would be the same, the density or the gradient of the fluid would be the same at the top of that 2000 foot column of oil as it is at the bottom?

Mr. Mattingly: I object to that question, your Honor, unless the question is further qualified by wh er there is a pump in the well, whether the pump is operating, and whether this column of oil that counsel is speaking of is merely a static column of oil in a static well.

The Court: Objection overruled.

(Testimony of Howard C. Pyle.)

A. And with these qualifications, I would s
that if it [520] were in a static column of oil th
the density would be approximately constant.

Mr. Babcock: Q. Well, let us answer counse
question then. What about in a pumping well, a
suming this column of oil we are talking abou
and there is any annular space between the tubi
and the casing, and suppose there is gas comi
up through it?

A. And it is producing? It isn't a static co
umn?

Q. No; it is a producing well; a pumping wel

A. Well, the density of the mixture would i
crease slightly with depth. In this first-mentione
example of a static column, oil is slightly compre
sible, so that with an increase in depth the oil b
comes compressed and more dense. Now, if yo
make it a flowing column, and disregarding for th
moment friction, gas is quite compressible, as w
know, and as you increase the depth you increas
the pressure, and for constant mixture your ga
occupies less space and your total mixture is mo
dense.

The Court: Does that mean that it is denser th
farther down you go in a pumping well?

A. Yes, sir.

The Court: Well, the same thing is true of
pumping well as a static well?

A. Yes; but for the mixture with gas it is tru
to a greater extent than it is for a mixture unde
static conditions.

(Testimony of Howard C. Pyle.)

The Court: And the variableness of the density would be greater in a pumping well than it would be in a static well? [521]

A. In a pumping well, yes, sir, producing appreciable quantities of gas.

Cross Examination

By Mr. Mattingly:

Q. When did Mr. Rubel tell you about the things that Mr. Jakosky was doing and ask you to cooperate with Mr. Jakosky on the working out of whatever it was he did?

A. To the best of my remembrance it was during 1935 or 1936, as I said before.

Q. Can you fix that date a little better? Wasn't it late in 1936?

A. I am afraid I can't fix it. I have no yardstick with which to refer to it in my mind.

Q. Perhaps you could fix it by the date on which you first became acquainted with the Depthograph methods and apparatus. When did you become acquainted with those?

A. To the best of my knowledge that was prior to this discussion.

Q. You became acquainted with the Depthograph apparatus and method prior to the time Mr. Rubel asked you to cooperate with Mr. Jakosky?

A. Yes, sir.

Q. Did you at that time know what the Depthograph methods of determining bottom hole pressures were?

(Testimony of Howard C. Pyle.)

A. I think I was generally familiar with it.

[522]

Q. And you were familiar with the fact that the method consisted of obtaining a fluid level at one gas pressure in the well, and then changing the gas pressure, obtaining another fluid level in the well, and from the relation of gas pressures to fluid levels calculate the bottom hole pressure?

A. I don't believe that I could say that I was that familiar with the method. I could say that I was familiar with the Depthograph equipment and procedure to determine fluid level. I cannot recall the details of the process of measuring bottom hole pressure that you speak of.

Q. At the time you became acquainted with the Depthograph methods and their apparatus, the Union Oil Company was not at that time engaged in obtaining fluid levels or bottom hole pressures by the use of fluid levels independently of the Depthograph Company, were they? A. No.

Q. Have you any idea why Mr. Rubel wanted you and Mr. Jakosky to cooperate with each other on the development of a sound fluid level finding device?

A Well, I had a discussion jointly with Mr. Rubel and Dr. Jakosky. Mr. Rubel had told Dr. Jakosky and he again stated it to me of his early interest and work with the measurement of fluid level in wells. And he told me that he had discussed this with Jakosky and that Jakosky was very much interested [523] in this early work; and

(Testimony of Howard C. Pyle.)

requested that should Jakosky become interested to the extent of the development of equipment would I see that the wells and engineering personnel, as required in connection with making tests of any equipment that might be developed, were provided for Dr. Jakosky. The reason for what was stated, was that should Dr. Jakosky develop anything, services would be made available to the Union Oil Company at a cost figure, which has been the case.

Q. Do I understand that last part of your answer to mean that the Echo-Meter has furnished the fluid level and pressure density, and production capacity information to the Union Oil Company at a reduced rate.

A. Qualifying, if I may, your question slightly, they furnish fluid level information. I am not familiar with whether one can group it all, or not, but their services have been at a cost plus 10% basis to the Union Oil Company.

Q. Does the Halliburton Oil Well Cementing Company continue to furnish the fluid level service or information to the Union Oil Company at a reduced rate? A. I understand they do.

Q. Do you know how that rate compares with the charges made by the Depthograph Company for similar service? A. No, I'm afraid I don't.

Q. You don't know whether it is higher or lower?

[524]

A. I presume that it is lower.

Q. In this conversation that you say took place between you and Mr. Rubel relative to Mr. Jakosky,

(Testimony of Howard C. Pyle.)

and what he was proposing to do, was the Depthograph Company and the activity of the Depthograph Company mentioned?

A. I don't recall that it was.

Q. You were familiar with the Depthograph apparatus and methods at that time? A. Yes.

Q. You testified that there were other methods besides this fluid level method of obtaining bottom hole pressure, such as the depth pressure recorder. Is it possible to use the depth pressure recorder to obtain your bottom hole pressure in an oil well that has a pump in it and the pump is operating, without first taking out the pumping apparatus, or at least the sucker rods and pump, in order to put the depth pressure recorder into the well?

A. Will you state the first part of the question?

The Court: I think you had better reframe it. What he wants to know is whether or not you can lower a depth pressure recorder in a well that has a pump in it. Isn't that right?

Mr. Mattingly: That is correct.

A. You can't, no. Now wait; I will qualify that by saying, yes. [525]

The Court: To the bottom of the hole?

A. Yes, and it is currently being done.

Q. To the bottom of the hole? A. Yes.

Q. While the pump is in it? A. Yes, sir.

Q. Without removing the pump?

A. Yes, sir. We are doing that in Mount Poso at the present time.

(Testimony of Howard C. Pyle.)

Mr. Mattingly: Q. Those are relatively shallow wells, are they not?

A. Yes. I think the depth is approximately 2000 or 2200 feet.

Q. The depth pressure recorder, is that lowered in the annular space between the tubing?

A. Yes.

Q. That is possible in a shallow well but it is not possible in a deep well, is it?

A. It has never been done to my knowledge in a deep well. I rather believe it has been used in deeper wells than 2200, but I am familiar with the work at Mount Poso.

Q. That has been done very recently?

A. Yes, it has been within the last two years.

The Court: That is the same size hole all the way down? [526]

A. Yes, in some cases, and in some cases the hole is reduced near the bottom.

Q. And cemented off?

A. The reduced pipe is merely hung in there. The larger pipe is cemented. [527]

ALBERT C. RUBEL,

called as a witness on behalf of the defendant, testified as follows:

My address is Union Oil Building, Tucker 2711, in Los Angeles. I am vice-president of the Union Oil Company of California, in charge of explora-

(Testimony of Albert C. Rubel.)

tion, production and development. I have been with the Union Oil Company approximately 20 years.

Mr. Babcock: Q. Are you familiar with the work done by the Union Oil Company in 1927 and 1928 relating to the use of sound signals to determine the level of fluids in oil wells?

A. Yes, sir.

Q. Will you state in a general way what took place in that connection at that time?

A. Along about 1927, in the Dominguez field we became interested in determining fluid levels in the annulus of pumping wells, and appealed to the research department of our company for some help, and was assigned a research man; I believe it was Dr. Wolcott; I believe that was the name. He came out and worked out with us an experimental machine for determining fluid level by means of firing a shot and making a sound at the casing-head, determining the time that it took for that sound to go down to the fluid level and be reflected and then recording that on a moving film by means of a mirror [528] and beam of light. Such an apparatus was actually built. It was used.

Q. Were any records made by the Union Oil Company at that time? A. Yes.

Mr. Mattingly: Your Honor, I object to questions being asked of this witness, and answers that he has given, unless it is first brought out that he has personal knowledge of what was done.

(Testimony of Albert C. Rubel.)

Mr. Babcock: Q. Do you have personal knowledge of what was done? A. I do.

Q. Did you take any part in the use of the apparatus, or anything of that sort?

A. Yes, I did.

Mr. Babcock: Q. I hand the witness certain documents which have been marked for identification Defendant's Exhibit P, P-1 and P-2, P-2 being a letter of four pages, and ask you if you can identify those documents. These happen to be photostats.

A. I have seen the document that appears to be the same as this; some correspondents about that time. This is on Union Oil Company stationery, and I assume it is the same thing.

Q. Are you referring to all these documents?

A. No, just this letter. [529]

Q. The letter is P-2?

A. I can only say as to this letter, P-1, that I saw the patent applications and various drawings and so forth, accompanying that at that time. Whether this is the same thing or not I would be unable to say, but I know there was such a document prepared at that time.

The Court: Patent applications for what?

A. For this device I described.

Mr. Babcock: Q. Am I to understand that the Union Oil Company did apply for a patent?

A. The Union Oil Company, through Dr. Wolcott, who was a member of the research department, applied for the patent at that time, yes, sir.

(Testimony of Albert C. Rubel.)

Mr. Mattingly: Q. Did you see the patent applications that were prepared and signed by Dr. Wolcott?

A. Yes, sir, I did. May I correct that statement. I saw the patent applications, and I do not know whether they were filed. I think I said patent applications were filed. I saw patent applications and I could not say whether they were filed or not.

Q. This document marked Defendant's Exhibit P-1 appears to be signed by Mr. Wolcott. I don't know his first name. What is that? Edson? [530]

A. I don't recall his name.

Q. It is dated May 16, 1927, and contains this statement: "Tests have been made at Dominguez during the past two weeks. On Tuesday, May 10, 1927, the echo could be heard very distinctly, using a telephone transmitter as microphone, one stage of amplification and a radio head-set as receiver. The sound was made by shooting a pistol across the top of the casing and also by striking metal against metal at the top of the casing. In the latter case the echo was very distinct."

Do you have any knowledge of what is referred to there? A. Yes, I do.

The Court: Does that refresh your recollection?

A. Yes, sir, it does. I accompanied Dr. Wolcott, I believe, in all the experiments that were conducted at the well. The preliminary tests were made, as indicated by that statement, by an amplifying device and head sets. The first experiments

(Testimony of Albert C. Rubel.)

were made by taking two pieces of metal and striking them together, and later I brought my pistol, which was a .22 caliber Colt Woodsman, and fired it, and later brought a .45 caliber six-shooter, and fired it across the casinghead, and I was present and heard the echoes and saw the entire manipulation.

The Court: You heard the echoes through the microphone, or you heard them—— [531]

A. Through the earphones, your Honor. That is what we did.

The Court: You heard the deep echo?

A. We heard echoes from the shot. I don't recall that we had any success at all by striking the metal together, but with the shot we could hear a number of different echoes coming from the well after the shot was gred. This experiment occurred in an idle well that had tubing hanging in it. And we were interested in the fluid level in the annulus between the tubing and the casing. It wasn't just an open well.

Mr. Babcock: Q. Does the drawing marked Defendant's Exhibit P, which is dated April 6, 1928, refresh your recollection as to the apparatus that was used by the Union Oil Company during 1927 or 1928?

A. Well, I would say diagrammatically that it corresponds roughly to my recollection of the apparatus that we subsequently put together to try to record these echoes.

Q. What do you mean by "subsequently"?

(Testimony of Albert C. Rubel.)

A. Well, after the preliminary work had been done with the amplifying device and the headphones, Dr. Wolcott devised a recording device for recording the sound waves of the return.

Q. Can you describe the recorder illustrated on this Exhibit P?

A. I think I can, generally. As I recall it was a mirror [532] attached to the diaphragm, which was again attached to the amplifying device. That mirror had a source of light which impinged on it and then the reflected beam was directed to an perture across which a 16-millimeter moving picture camera film was drawn by the mechanism of a camera. We used an old camera, as a matter of fact, for that purpose. The vibrations of the diaphragm would cause an oscillation of the mirror which in turn would cause an oscillation of the light beam, and that oscillation of the light beam recorded on the film the magnitude of the oscillation, being in proportion to the energy of the vibration. And the movement of the film, of course, stretched that out into a sine curve, and the magnitude, then, of the vibrations that came back were recorded on this film. That is the way the record was made. It was a crude device. The audio amplification unit was taken from a radio. As I say, the recording device was a 16-millimeter camera, and the mirror and light source were made separately, and was all enclosed in a ply-wood box.

(Testimony of Albert C. Rubel.)

Q. Do you know what the device indicated at 11 on the drawing is?

Mr. Babcock: That No. 11, your Honor, appears right on the device.

A. I wouldn't know from that drawing, but I would assume that there would be a recording device there in the form of a [533] microphone. That is what we used at the casinghead.

Q. What is the device indicated by the numeral 6?

A. I presume that indicates the source of the sound. At that time we were experimenting, as I said, with a number of different sources of sound. We used this metal striking together, we used two calibers of pistol shots. As I recall, we used a string of a musical instrument, a mandolin or guitar, and we stretched that to get different amplitudes of sound. And then later Dr. Wolcott devised an oscillating tube as a source of sound. Whether that was ever used in the well or not I do not recall.

Cross Examination

By Mr. Mattingly:

Q. I believe you stated that the work that you testified was done in 1927 or 1928. When was that work actually done?

A. I don't recall the exact dates. It was some time between the middle of 1927 and the latter part of 1928. That is as close as I can fix it from memory.

Q. The apparatus that you have described as

(Testimony of Albert C. Rubel.)

including an old motion picture camera and a light and a mirror, that was actually constructed, was it? A. Yes, sir.

Q. That was constructed as early at least as 1928? [534]

A. It was constructed earlier than the end of 1928. That is about as close as I can come to it. I have to fix this date by reference to other things. I left the Dominguez field in the early part of 1929, and all this work occurred prior to that time, so I know it came in that general period, but I can't fix the date any closer than that from my own recollection.

Q. What was done with this apparatus that you say was completed after 1928?

A. I do not know what disposition was made of it.

Q. So far as you know, the apparatus was not used subsequently to that time, is that correct?

A. It was not used on any Union Oil property subsequent to 1928, to my knowledge.

The Court: Why not?

A. The work was discontinued, your Honor, about that time, and there was no further attempt made to develop it.

The Court: The work? You mean the work of endeavoring to find the fluid level?

A. Yes, sir. It was about that time that the big oil boom started. And the Santa Fe Springs were deep drilling, and we were very much occu-

(Testimony of Albert C. Rubel.)

pied with other things, so we discontinued the work. [535]

Mr. Mattingly: Q. Isn't it true that the next work which was done by the Union Oil Company, in connection with any sound apparatus for finding fluid levels, was subsequent to 1936; in fact, in the middle or last part of 1937?

A. Well, again, I would be unable to fix a date, but it was some considerable time after that and probably about in that period. I recall the work that we did, but I don't recall the date. [536]

Mr. Graham: The defendant offers in evidence a certified copy of the file wrapper which resulted in patent No. 2,156,519, which is the first patent in suit, as Defendant's Exhibit T.

[Printer's Note: Defendant's Exhibit T is set out in full in the Book of Exhibits.]

We offer in evidence a certified copy of the file wrapper of the application which resulted in the Lehr and Wyatt patent No. 2,047,974, as Defendant's Exhibit U.

[Printer's Note: Defendant's Exhibit U is set out in full in the Book of Exhibits.]

Mr. Mattingly: Your Honor, I object to the entry of the file wrapper of the Lehr and Wyatt patent. That is not a patent in suit, and the proceedings which went on in the Patent Office in connection with that patent I do not believe are material to any issue in this case.

The Court: Why isn't it material? You allege

(Testimony of Albert C. Rubel.)

in your original patent that it was an improvement on the Wyatt and Lehr. How am I going to know that it was an improvement unless I know what the Wyatt and Lehr patent is?

Mr. Mattingly: The Wyatt and Lehr patent is in evidence. My point is, I don't feel that the file wrapper is material to the case.

The Court: Objection overruled.

Mr. Graham: We offer in evidence the file wrapper, serial No. 164,534, which has already been offered for identification as Defendant's Exhibit L.

[Printer's Note: Defendant's Exhibit L is set out in full in the Book of Exhibits.] [537]

CRANFORD P. WALKER

recalled by the defendant.

Mr. Babcock: If the Court please, I am calling this witness under Rule 43 (b) of the Federal Rules of Civil Procedure. Your Honor, when we took Mr. Walker's deposition, I asked him certain questions about the date when the exact method of patent 2,209,944 was put in public use, and Counsel has agreed to stipulate that the exact method of that patent went into public use beginning on March 6, 1937, so I will not ask the witness any more questions about that.

Mr. Mattingly: So stipulated.

Mr. Babcock: Q. Mr. Walker, you have testified, I believe, that the first time you saw an apparatus for determining the level of fluid in wells, by

(Testimony of Cranford P. Walker.)

sonic methods, was in the Fall of 1935 when you saw Mr. Lehr demonstrate the apparatus to you?

A. Yes, that is correct.

Q. Do you know when you first saw the Wyatt and Lehr patent that we have been talking about in this suit?

A. It was soon after it was issued in 1936, I believe.

Q. Did you see the application before the patent had been issued to Wyatt and Lehr, the Wyatt and Lehr application?

A. Yes, I had seen the application.

Q. When did you first see that?

A. I haven't the slightest idea. My records might show when I was permitted to see it, but I haven't any idea; but it [538] was some time after, and quite a little while after I started work on this problem actively.

Q. Can you fix the date by reference to when you first saw this apparatus demonstrated?

A. I would say it was—my guess would be that it was several months after that. I have tried to recall that date, but I can't, and I have no way of fixing it. [539]

Q. The Wyatt and Lehr patent issued July 21, 1936. At some time or other, in your work on the Depthograph, you thought of the idea of putting a filter in an amplifier in a recording system, did you not, an electrical filter in an amplifier of a recording system for recording echoes from a well, in a system such as we have been dealing with here?

(Testimony of Cranford P. Walker.)

A. The amplifier that I used in making the re ords that have been submitted in evidence had filter on it, a tone control, it is called in the ordinar radio outfit. This was used, I understand it, fo recording heart beats and had a filter on it which used in my experiments, but it did not have muc effect.

Q. What date are you referring to?

A. I am referring to experiments in the ear part of November.

Q. What year?

A. 1935; November 13th to along towards th latter part of the month.

Q. That apparatus, was that an apparatus tha had a microphone and an oscillograph in this record ing circuit with the amplifier?

A. That is correct.

Q. That filter was a low pass, a low frequenc filter; it was not a resonant tuned circuit, was it

A. I do not know, Mr. Babcock, just what typ of filter [540] it was.

Q. Was it the type of filter that is shown an described in your patent application, now offere as defendant's Exhibit L.

A. I have just testified that I did not know wha type it was. I did not make a very close examina tion of it, so I therefore can't make any comparison between the two.

Q. When did you first conceive of the idea o using a filter in an amplifier circuit in a recordin system which has a microphone recorder as shown

(Testimony of Cranford P. Walker.)

in figure 5 of the drawing of application serial No. 164,534, offered as defendant's Exhibit L?

A. To the best of my knowledge that was about the time that I started experimenting with accoustical tuning, which was during the early part of 1937.

The Court: When you say "experimenting with accoustical tuning", you mean mechanical tuning?

A. Mechanical tuning, that's right, your Honor.

Q. Mr. Walker, in these Depthograph and Echo-Meter operations do you regard the shooting of a gun as the full equivalent of a pressure impulse chamber to initiate the sound or wave to be reflected?

A. They both produced a pressure wave, and the return [541] echo is almost identical with the two methods in wave form, I would say.

Q. Answer the question please, sir.

A. Your statement "full equivalent"—I would not like to say "yes", worded that way. To all practical purposes I would say "yes", the two are the same. Using a pressure impulse has some advantages; it is a little more flexible; that is why I would like to give a conditional answer. They are not exactly the same, but to all practical purposes they are the same. [542]

CRANFORD P. WALKER

recalled as a witness on behalf of plaintiffs, in rebuttal, testified as follows:

(Testimony of Cranford P. Walker.)

Direct Examination

Mr. Mattingly: Q. Mr. Walker, during the taking of your direct testimony you mentioned the fact that a certain application for patent, which is in evidence now as Defendant's Exhibit A, was abandoned. Will you explain to the court the circumstances under which you abandoned that application? That, for your information, is the application for which an application was filed which resulted in patent 2,209,944.

The Court: Didn't he go into this before?

Mr. Mattingly: This is the testimony that your Honor interrupted and said that it was proper rebuttal testimony. This being rebuttal, I would like to get this testimony in.

The Court: All right.

A. Before patent 2,209,944 was issued, or ready to be issued, two other patents in suit here were issued, namely, 2,156,519 and 2,161,733, which was the reissue, and 21,383, and we notified our competitor at that time, Mr. J. J. Jakosky, who was head of the International Geophysics, Incorporated, of his infringement of those two patents. Mr. Jakosky expressed a desire to be licensed to operate under those two patents, and negotiations with him began very soon after these patents were issued, and I believe that was during the middle of 1939. [543]

Mr. Graham: Your Honor, I fail to see the relevancy of talking to Mr. Jakosky, or what Mr. Jakosky wanted, and what they agreed to do with filing these applications.

(Testimony of Cranford P. Walker.)

The Court: I think the evidence is admissible, anyhow.

Mr. Graham: Your Honor, may I say a word on that?

The Court: Yes.

Mr. Graham: As I understand from the evidence as it is going now, Counsel has made it a point that the Commissioner of Patents has discretion; he examines the file and after he examines the file he makes up his mind. Now, may I ask Counsel if any of this testimony he is going to get from this witness on that point was before the Commissioner of Patents when he so-called made up his mind?

Mr. Mattingly: It was not.

Mr. Graham: Then how is it before this Court?

The Court: It seems to me that the evidence which would be adduced by the answer to the question, as indicated by the question, and the subject matter to be covered by it, whether or not it is admissible under your present theory, is admissible by way of estoppel against the defendants.

Mr. Graham: Against the defendants?

The Court: Hasn't there been some evidence here that Jakosky was the predecessor in interest who made or who devised these machines?

Mr. Graham: He had nothing to do with these applications, [544] your Honor.

The Court: No.

Mr. Graham: No connection with them.

The Court: I am not speaking of that, at all. But the thought which occurred to me is that if

(Testimony of Cranford P. Walker.)

you are getting the benefit of your agent, and assuming that Jakosky was your agent or your predecessor in interest, you cannot be held to complain now if he induced the plaintiff here to act against the plaintiffs' interest.

Mr. Graham: I don't get it, your Honor.

The Court: In other words, assuming that your contention of the law is correct, then the question arises as to whether or not you were estopped from asserting that.

Mr. Graham: Well, I haven't seen any evidence here that could even remotely be connected with that, your Honor.

The Court: I don't know whether it was testified on the witness stand, but I read from the deposition, I guess I shouldn't have read the deposition. But I recall that Mr. Jakosky was the man who built the Echometer——

Mr. Graham: Originally, yes.

Mr. Graham: That is correct.

The Court: And that the present defendant in this case took over this equipment and his business, the exclusive right to use [545] that equipment.

Mr. Graham: That is correct.

The Court: Now, whatever you have got depends upon Jakosky, doesn't it? I mean, if Jakosky hadn't produced it or made it, you wouldn't have it. Whatever you have got comes from Jakosky. Now, if Jakosky, the man upon whom you rely, induced the plaintiff to act against his interest by unfair means or unlawful means or fradulent

(Testimony of Cranford P. Walker.)

meant, or any means short of those which would stop Jakosky from complaining of the plaintiffs' abandonment and filing a renewal, then it seems to me that it would be admissible as against you.

Mr. Graham: Well, it certainly will, and I have no objection to counsel asking any questions on that, because there is nothing of that kind in the case, your Honor. You don't claim there is, do you, Mr. Mattingly?

Mr. Mattingly: Let's see what the evidence is.

Mr. Graham: Do you plead any estoppel of that kind?

Mr. Mattingly: I have not pleaded any estoppel of your right to raise this defense.

Mr. Graham: Well, for the purposes of understanding the testimony, are you making a statement that you are claiming, under any circumstances whatever, that Mr. Jakosky has influenced this witness in connection with abandoning the original application of 2,209,944 or filing a new application?

Mr. Mattingly: Yes, I feel that Mr. Jakosky did, by his [546] acts and statements, induce this witness to take the course of procedure which he did.

Mr. Graham: All right.

Mr. Mattingly: Q. As I recall, Mr. Walker, I was asking you to state the circumstances which led you to abandon application Serial No. 270,865, Defendant's Exhibit A, and file a continuing application, which finally resulted in patent 2,209,944——

Mr. Mattingly: Shall I go on and recite what I remember of the witness' answer up to the time——

(Testimony of Cranford P. Walker.)

The Court: Well, you ask your questions.

A. If I remember correctly I stated that negotiations had started between ourselves and Mr. Jakosky with a view of granting him a license under the two previously issued patents, the numbers of which I have already given.

The Court: Which numbers? Tell us again. The Wyatt and Lehr——

A. The first two patents that were issued to me, your Honor, namely, 2,156,519 and 2,161,733, reissued as 21,383.

The Court: Well, had 21,383 been issued when these conversations occurred with Jakosky?

A. No, they hadn't. During those negotiations Mr. Jakosky severely criticized the way in which the claims had been drawn and the patents in general, and much of it I thought was, at least I hoped was to frighten me into a favorable contract with him; but, nevertheless, I lost considerable sleep over his criticisms of the claims. During that time this application, which [547] resulted in 2,209,944 was pending.

Mr. Mattingly: Q. Will you give the serial number of that application? Is that 270,865?

A. That is my understanding. 270,865 was the application number at that time. Previously I had assumed that if an idea were completely disclosed and a claim was drawn covering, in a general way, what the idea was, that the subject was covered pretty thoroughly, and somebody else got up some little different way of doing something it wouldn't

(Testimony of Cranford P. Walker.)

make any appreciable difference as long as the basic idea was the same. But his criticisms were not in agreement with that idea of mine, so I began worrying about this other application. But in the meantime the patent was allowed, and without any authorization from me the fee was paid, without my knowing it, and I had no way of making any changes. After talking with Mr. Jakosky I wanted to consult other patent attorneys on the subject, and I did subsequently consult two other firms regarding those claims.

Q. Will you tell us who the firms were?

A. Mr. Robert Smith, an independent attorney operating independently, and Mr. Leonard Lyon, of Lyon and Lyon.

Q. What did you do when you found the patent application had been allowed and the final fee had been paid?

A. I got very much excited about it, and was advised that one way to have a thorough reconsideration of the application—incidentally, the application had a couple of claims which were [548] not properly worded and the meaning, according to my interpretation, was changed by the way they were worded, from what was meant. Those corrections were subsequently made. The application was abandoned and immediately the continuation was filed——

A. As I was saying, the other two patents had taken so long to get through the Patent Office, and this division was filed only in April, 1939, and I had

(Testimony of Cranford P. Walker.)

not expected it to issue as a patent for a considerable time after it actually did issue, and it was very much of a surprise to me when it had been allowed and the final fee paid.

The Court: Now, I understand that Jakosky talked to you between May 6, 1939, and September 14, 1939?

A. That is correct, your Honor. The negotiations with Mr. Jakosky began early in July, if I remember correctly, because that followed very soon after we notified him, which was July 6th, I believe, 1939.

Q. Up to that time you had only had one patent issued, hadn't you?

A. No, your Honor, there had been two patents issued.

Q. What was the second? There was 2,156,519—2,161,733?

A. That is correct.

Q. All right, go ahead.

Mr. Mattingly: Q. I believe you said you subsequently conferred with two other attorneys, Mr. Smith and Mr. Leonard Lyon?

A. Yes, sir. [549]

Q. What was the result of your consultation with those attorneys?

A. Two claims, if I remember correctly, were added, and before those consultations these corrections had been made. They, in fact, had been made in this renewal or continuation which occurred—well, I am not an attorney; I haven't the informa-

(Testimony of Cranford P. Walker.)

tion anyway. As soon as it was abandoned and renewed, these corrections, and probably some more changes were included; then we began consulting other attorneys.

Q. And these additional claims that you have referred to were put into this continuing application which did result in patent No. 2,209,944?

A. That is correct.

The Court: Where did these negotiations take place with Jakosky?

A. The first meeting was in Mr. Mattingly's office, and those present were Mr. Knight, according to what I understood at that time, was Mr. Jakosky's attorney, Mr. Mattingly, Mr. Robert Miller, and myself. That is correct, isn't it?

Mr. Mattingly: I think that is correct.

The Court: Q. Who said what to who?

A. Mr. Jakosky did most of the talking, I believe.

Q. What did he say?

A. He criticised the details of the specifications.

Q. Criticising is a conclusion. I am supposed to [550] decide whether or not he criticised. Tell me what he said.

A. He said we had not included certain things in some of these specifications which should have been included, and it looked like we were going to work together and work out some sort of a cross-license arrangement, and he made some constructive criticisms, I believe, as to what should be done, but

(Testimony of Cranford P. Walker.)

as to the details of the criticism, I don't recall, your Honor.

Q. What did you say?

A. As little as possible.

Q. Did you indicate to him by your attitude or your language that he could expect a licensing arrangement?

A. I think we did. Only one thing stands out in my mind. He said, "You should have applied for electric tuning in this thing. Why didn't you apply for electrical tuning? You have applied for acoustical tuning." I could hardly keep from smiling, because I had already done it.

Q. You did not tell him you had already done it?

A. No.

Q. You did not? A. No.

Q. Did you rely upon what Mr. Jakosky said?

A. He was considered, some say, as quite a patent authority, and others say as a patent shark. I don't know which is the correct description; but it gave me cause to worry about the way the patent claims had been drawn. In answering your question as to [551] where the meeting took place, several meetings took place in Mr. Robert Miller's office.

Q. Who was he?

A. My partner, or one of my partners, with Mr. Jakosky, Mr. Miller and I, and sometimes some one else in Mr. Jakosky's office. I don't recall just who else was there. I think the last meeting we had Mr. Philip Subkow was with us, and that was in,

(Testimony of Cranford P. Walker.)

I think, Mr. Subkow's office. I think it was in February, 1940.

Mr. Mattingly: Q. I show you a record, and ask you if that is a record which you made at the well in Kansas with a gun shot initiated by the defendant's apparatus?

A. That is; that is correct.

The Court: You want that marked, I suppose, as Plaintiffs' 33. That is a record by the plaintiff of the defendant's shot in Kansas?

Mr. Mattingly: I will offer that record in evidence your Honor.

The Court: It may be admitted.

The Clerk: Plaintiffs' Exhibit 33 in evidence.

The Court: I suppose you have got 34 now, as a record in the same well of Plaintiffs' pressure impulse?

Mr. Mattingly: That is correct, your Honor, and our record strip—is that the record strip that was made at the same well from an impulse which was initiated by the Depthograph pressure chamber?

[552]

A. It is.

Mr. Mattingly: I offer that record in evidence as Plaintiffs' Exhibit No. 34.

The Court: This will be Plaintiffs' Exhibit No. 34.

Cross Examination

Mr. Graham: Q. These talks with Dr. Jakosky, when were they, Mr. Walker?

A. They extended over a period, if I remember

(Testimony of Cranford P. Walker.)

it correctly, shortly after we notified him that he was infringing the two issued patents until, I believe the last meeting, as I have stated previously, was in February, 1940; from about the middle of 1939 to probably the early part of 1940.

Q. When was it he talked to you and you got so agitated about the claims?

A. That was brought on by the payment of this final fee by Mr. Jones on this patent application.

Q. Did you not at that time know all about, or long prior to that time, know just what Mr. Jakosky was doing?

A. I knew something about what he was doing.

Q. You knew enough about it in February, 1939, to file an affidavit in the patent office claiming that in your opinion what he was doing constituted infringement of the claims in your patent application, didn't you? A. Yes. [553]

Q. Now, referring to your deposition that was taken in this case on February 28, 1942, you were interrogated by Mr. Babcock as to the reasons why you abandoned this application, and on page 95 of that deposition Mr. Babcock stated:

"I am talking about the prosecution, about whether you abandoned that application. The witness has testified that he collaborated with Mr. Mattingly in the prosecution; the file history contains a document which purports to be his statement, signed by him, expressly abandoning the application. I want to know if he recalls discussing it with you, whether he ought to abandon that application.

(Testimony of Cranford P. Walker.)

"A. Yes, there was some discussion about going through some patent office formality, which I wasn't familiar with, which might have involved a temporary abandonment of this application.

"Q. By that time, by the date you signed that abandonment there,—what is that date, by the way—September 22, 1939, you knew all about what Jakosky and the International Geophysics, Inc. were doing, did you not?

"A. No, I can't say that I did.

"Q. You knew nothing about what they were doing?

"A. I knew very little about what they were doing.

"Q. Mr. Walker, in another application you filed an affidavit that you knew all about what they were doing, and that they were infringing this method and all your methods; did you not file it right in the patent office six months before that time? [554]

"A. I doubt very much that I stated that I knew all about what they were doing; that of course would not have been a true statement.

"Q. Well, did that have anything to do with abandoning this application,—what they were doing, what Jakosky and his group were doing?

"A. Nothing that I know of.

"Q. Why did you abandon that application?

"A. If I remember correctly, it was to reword some of the claims.

"Q. Do you recall whether you — let me say first,—where were you, do you know, when you

(Testimony of Cranford P. Walker.)

signed this abandonment; can you tell from that paper, the address of it?

"A. No; I don't recall."

Do you recall of so testifying, Mr. Walker?

A. Yes.

The Court: What page is that on?

Mr. Graham: Q. And on page 100 of that same deposition:

"Q. You have no recollection of being in Mr. Mattingly's office, and on the same day abandoning application, Serial No. 270,865 and signing the oath for the application which has matured into patent 2,209,944?

"A. I can't say at this time when or where the others were signed—

"Q. Well, you have no recollection of discussing that with [555] Mr. Mattingly, or anything of the kind?

"A. Discussing the signing of papers?

"Q. Yes, abandoning the first, and filing the second?

"A. Yes, that was discussed.

"Q. Don't you know why you wanted to abandon the first and file the second?

"A. Well, I would say it was probably to make some corrections.

"Q. It is a cinch you would not just want to spend another thirty dollars, once you had this first all allowed here; why did you want to pay another thirty dollars and file a new one on the same thing?

(Testimony of Cranford P. Walker.)

"Mr. Mattingly: Is that a question?

"Mr. Babcock: Yes.

"A. I am afraid you will have to ask my attorney about that.

"Q. You haven't any idea, he didn't tell you why you should give him another fee and pay another thirty dollars to the Patent Office?

"A. I suppose he has to live.

"Q. You have no recollection at all, is that correct?

"A. As to the details of why it was changed, that is correct. It was for the purpose of correcting mistakes, as I recall.

"Q. But you are sure it had nothing to do with repatenting it so that you could cover what the International Geophysics were doing, or what Jakosky was doing?

"A. I don't know for sure just what he was doing, in detail." [556]

Q. Is that a correct statement of your testimony at that time, Mr. Walker?

A. I think it is, except you skipped some of it.

Q. Now, you have spoken about calling in other attorneys and conferring. How long was it after you abandoned your application and filed a new application that you had this conference with other attorneys? Wasn't it six months?

A. I don't think so. It was some time after that occured.

Mr. Graham: Well, that is all right. We will

(Testimony of Cranford P. Walker.)

show that from the file histories that are in evidence at this time.

Q. Do you recall in this so-called continued application you permitted that to become allowed, then after it was allowed added some claims in July, 1940?

Mr. Mattingly: I think the file history of that application speaks for itself. This witness can't add anything to it or detract anything from it.

The Court: Yes, it does, but he has a right to ask him whether or not he recalls it. Do you recall it? A. I believe I do, your Honor.

Mr. Graham: Q. And do you recall whether or not they were the only claims that were added to that application?

A. My memory is that two claims were added. The records will show, but that is my memory.

Mr. Mattingly: The plaintiff rests.

Mr. Graham: The defendant rests, your Honor.

[557]

The following colloquy occurred at the oral argument:

Mr. Graham: There is one thing, your Honor, that I might say right here. It has been rather indefinite. I don't know what is in your Honor's mind, but it has not been clear at all just what the plaintiff relied on, and does rely on, as to infringement of that first patent, (2,156,519) in this respect: He apparently depends upon the law of equivalency. Whether that is in your Honor's mind or not, I don't know.

The Court: Yes, it is.

Mr. Graham: I would like a statement from the plaintiff, so that we can talk on the subject directly, as to what part of defendant's apparatus he relies on as being the equivalent of what part of plaintiffs' apparatus.

The Court: Here is what is in my mind. I think it is the same means relating to the pressure impulse; the pressure responsive device, accoustical tuning, the introduction of the impulse in the responsive device, and the accoustical tuning, and there is one other—and the recorder, used together—as I understand, no claim is made that the recorder is new, but they are all used together. I think that everything that the defendant does here is the equivalent of what the plaintiff does, or is an imitation.

Mr. Graham: In the opening statement I asked Mr. Mattingly, if we omitted the filter from our apparatus, did [558] he claim infringement, and he said, no.

The Court: Yes; I remember that question and that answer. I wondered what its significance was at the time, and I don't know that it is clear to me yet.

Mr. Graham: Your Honor, here is the point: With that statement, we have proceeded on the theory that the statement should be binding on the plaintiff; that is, if we leave the filter out of our apparatus, then we don't infringe. The testimony is that we don't use it except on some occasions;

we don't use it all the time, and we can do without it.

The Court: Yes, the testimony is very clear. But you don't count tubing collars when you leave the filter out.

Mr. Graham: Certainly, we do.

The Court: When you leave the filter out?

Mr. Graham: Yes. If that is true, then we don't infringe if we leave the filter out. I want counsel to say what part of plaintiff's patent he claims the filter to be an equivalent of.

Mr. Mattingly: I consider, in connection with the filter, together with the amplifier, that the filter works in such manner as to cause your tubing collar echoes to stand out above disturbances and noises, and that, we consider is the equivalent of our accoustical tuning pipe, which we use between the diaphragm and well connection for the purpose of doing exactly the same thing, namely, making the tubing [559] collar echoes stand out above the disturbances and noises.

Mr. Graham: That is a clear statement; and I understand it to be that with the filter left out we do not infringe, but with the filter in, then the filter in combination with the amplifier is the equivalent of your acoustical resonance chamber, which is the pipe adjustable in length.

The Court: Tuned acoustical resonator?

Mr. Mattingly: I would like to correct one impression; that is, in answer to Mr. Graham's question, whether or not if the defendant left the filter

out of its system, would that infringe? May I ask if that is, that it would not infringe unless they used something else in their system which did accomplish the result of tuning and making these collars more active?

The Court: What would that be?

Mr. Mattingly: You can use a particular kind of amplifier, for example—I don't know what the ingenuity of the defendant might devise to take its place—that would cause these collars to be accented above the noise, and other things, which both plaintiff and defendant in actual practice have found to interfere with the clear registration of tubing collar echoes.

Mr. Graham: We are dealing with whatever they are using in the defendant's device before the court. We are not dealing with conjectures and possibilities. It is this thing [560] that is here. Consequently the question is: If we were enjoined on that patent, and we left the filter out, then we are free of the patent, as I understand your statement. Are you challenging that?

Mr. Mattingly: If you left the filter out and used the same amplifier you are now using. If all you did with your device was to leave the filter out, then I do not believe you infringe the claims of the patent by doing that.

The Court: 2,156,519?

Mr. Mattingly: Yes. I think one of the difficulties perhaps Mr. Graham is laboring under—I know it has given us difficulty in this case—is to

get a true picture of exactly what the word "filter" covers. In testifying Dr. Mackeown consistently testified and considered the filter circuit as an independent device, something which was independent of the amplifier, and he treated the two as two separate items, and yet, in his cross examination he admitted that the filter in combination with the amplifier, that is, the filter-amplifier combination, was the thing which constituted the accenting of the tubing collar echoes.

Mr. Babcock: Your Honor, we made several tests. We took the plaintiff out, and showed him. We made records with filters and tests without the filter. They are in evidence. I don't know just what the exhibits are, but you can hardly tell them apart; the one out on the Callender well, out at [561] Dominguez.

Mr. Mattingly: You can count collars on one as well as on the other. Each little wiggle is a different shape, and the filter makes them a little easier to count that way. It takes out the noise, and other things.

The Court: As I remember those exhibits, the one where the filter was not used there was considerable violent action in the recording device, so it was almost impossible to read it until you got down in the well further. With the filter on it you could read it at once.

It looks to me if when the defendant doesn't use the tuning device, then it doesn't infringe 2,156,519.

Mr. Mattingly: That is correct.

The Court: You say you don't use that?

Mr. Graham: We don't say that. In most of the cases we don't.

The Court: So far as the plaintiff is concerned, it looks to me that you should waste no further time on the apparatus of 2,156,519 in view of your statement, in other words, that they do not infringe unless they use the filter.

Mr. Mattingly: They do not infringe unless they use the filter, or an equivalent tuning means.

The Court: Or an equivalent tuning means; and on that point, I think your tuning apparatus is an equivalent of their recording device. [562]

Mr. Graham: I want to make a statement. I don't want anything we have said to be construed as an admission on our part, even with the filter, your Honor, that it is an infringement, because we have something to say on that subject.

The Court: The plaintiff does not need to waste any more time on that.

They have said you don't infringe unless you use the equivalent of a tuning device, or the tuning device. They say if you don't do that you don't infringe.

Mr. Graham: We are not going to stop using the filter. I don't admit that that is a tuning device, but I say we are not going to stop using that filter unless the court enjoins us against using a filter.

The Court: Inasmuch as the matter of whether it is a pressure impulse or a shot is concerned, if

you don't infringe it doesn't make any difference whether you use a pressure impulse by gas, by a short introduced into the well, or whether you suck the gas out, or blow it out, as long as you don't use the tuning device, or its equivalent, on 2,156,519, isn't that your position?

Mr. Mattingly: That is correct.

Mr. Babcock: Relative to reissue patent 21,383, I have here on this sheet six ways of measuring bottom hole pressure under various conditions. Let me give you a copy of this, your Honor. [563]

(The Court was thereupon given a copy of a paper reading as follows:

"A. Some Ways to Measure Bottom Hole Pressure:

1. Conditions: An open well. Density of fluid known or determined by catching sample and weighing it or the like.
   Procedure: Make a fluid level determination. Multiply height of fluid column by density which gives bottom hole pressure.

2. Conditions: Closed-in well with gas above fluid. Density of fluid known or determined by weighing sample or the like.
   Procedure: Make fluid level determination. Multiply height of fluid column by density of fluid to get pressure on bottom due to fluid. Add pressure due to gas (casing head pressure corrected by Dice's formula or the like.)

3. Conditions: An open well. Density of fluid unknown.
   Procedure: Determine density by measuring pressure at two different fluid levels; then proceed as in (1).

4. Conditions: Closed-in well with gas above fluid. Density of fluid unknown.
   Procedure: Determine density by measuring pressure [564] at two different fluid levels; then proceed as in (2).

5. Conditions: Same as (4).
   Procedure: Increase gas pressure until all the fluid is out of well, so that gas pressure is bottom hole pressure. Measure casing head pressure and apply Dice's formula.

6. Conditions: Same as (4).
   Procedure: Increase gas pressure enough to depress fluid some measurable distance. From this, estimate how much casing head gas pressure would be required to force fluid clear to bottom. Apply Dice's formula to the estimate.

B. Some Ways to Estimate Production Capacity:

1. Compare variations in bottom hole pressure with variations in pumping rates.

2. Compare variations in fluid level with variations in pumping rates."

The Court: Do you have one more for Mr. Mattingly?

Mr. Babcock: Yes. I would like to consider which of these various ways this patent (Reissue 21,383) is really supposed to cover. I can't conceive that it would cover No. 1, where, as I say, you just had, say, a water well; you knew the density of the fluid, and all you did was to find out how much height of fluid you had. I might ask counsel: Is there [565] any contention that that would be infringement of this patent?

Mr. Mattingly: I am not sure that I understand the issue you are setting up.

Mr. Babcock: Here is what we do in Kansas; it is very common to just have an open oil well, no gas coming off, and everybody knows the gravity of the oil being produced; and we go out to the well with this Echo-Meter, and find out the fluid level.

The Court: Just one fluid level?

Mr. Babcock: Just one fluid level. From that the operator, or anybody else, can calculate the bottom hole pressure, because he knows the density of the liquid in the hole.

The Court: That is on the assumption that the oil that is coming out of the hole is the same gravity fluid that is in the annular space?

Mr. Babcock: Yes. The well is making no gas. Just ordinary oil. I can't conceive that that would infringe this patent.

Mr. Mattingly: No, that would not infringe the

patent, because each one of the patent claims in Reissue 21,383 specifies that you must take two fluid levels under two different pressure conditions. If you only take one fluid level, it doesn't infringe those claims.

Mr. Babcock: Referring again to this memorandum, I [566] gather from the discussion I have just had with counsel that it will not be contended that item No. 2 will infringe.

Mr. Mattingly: Where you are making only one fluid level determination, I think that is right.

The Court: No. 3 has two fluid level determinations. He contends there is *there*?

Mr. Babcock: No doubt. Also No. 4. What about No. 5, where you have a closed-in well with gas above the fluid, but you force all the fluid out, and just determine the gas pressure?

Mr. Mattingly: I don't think we have any claim in patent Reissue 21,383 on which that would read.

Mr. Babcock: What about No. 6, where, instead of forcing it clear down you only force it down enough to determine how much gas pressure would be necessary to force it clear down?

Mr. Mattingly: That would be infringement.

The Court: You have to make two fluid level measurements there?

Mr. Mattingly: That's right.

Mr. Babcock: Yes, and then extrapolate. Also on this chart we have two ways of determining the production capacity of a well.

No. 1 would be like Figures 4 and 5 of the reissue

patent, where you determine two bottom hole pressures at two different pumping rates. I presume it will be charged [567] that would be infringement?

Mr. Mattingly: Not unless you go further, and state how you get these two bottom hole pressures. Our claims in patent Reissue 21,383, directed to obtaining production rates, specify that you have to use two fluid levels at one rate of production, and then two fluid levels at a second rate of production, and then make your comparisons. This patent would not be broad enough to cover the use of a pressure recorder which is put in the well, and then the well operated at two different pumping rates. We don't contend our patent covers that.

The Court: Comparing the bottom hole pressure with variations in pumping rate; you concede that wouldn't be an infringement, unless they use more than one fluid level?

Mr. Mattingly: To obtain the bottom hole pressure.

The Court: So any way they can obtain bottom hole pressure, otherwise than by method 1, 2 or 5, no infringement is charged unless it be obtained by at least two fluid level determinations?

Mr. Mattingly: That is correct.

I would like at this time to move that claim 6 of Reissue patent 21,383 be considered as one of the claims in suit in this case. I do not think that any of the defenses which have been asserted here will alter the defense at all by the inclusion of

claim 6 as a part of the suit, because such defenses would be directed [568] against that claim as the balance of the claims. It would not, as I see it, prejudice the defendant's position at this time, if we admit claim 6 is one of the claims in suit.

Mr. Babcock: We don't care, your Honor.

The Court: If you don't care I will grant plaintiffs' motion; plaintiffs' motion to amend the pleadings to conform to the proof.

Mr. Mattingly: That's right.

The Court: So as to include claim 6 of patent 21,383 as being infringed, and included within the request for relief. That is granted.

Mr. Babcock: Your Honor wanted me to discuss the question of renewal.

The Court: 2,209,944 is the renewal patent?

Mr. Babcock: Yes. That defense goes only to 2,209,944.

The Court: I am not impressed with your defense on that so far, even in spite of the very able and overwhelming argument that Mr. Graham put forth; but it seems to me that Section 38 had an entirely different application, a different application in the mind of Congress. I think plaintiffs' position on that is correct, but the entrails of the patent, whether or not it is invention, it does not strike me that 2,209,944 is invention.

In other words, with the repeal of that statute I don't think it affected plaintiffs' right at all, and I think that he, having paid the fee and applied for a renewal, that he was within [569] his rights in

doing so, and abandoning the patent before it was issued.

Plaintiff here had not secured his patent. He applied; he paid his fee, which was to say: Yes, that's what I want. Then he discovered that it was not, and he said: Just a minute, Mr. Government, I don't want that patent. I am going to abandon this by filing a continuation, because there are some things I want to change.—I may be wrong on the law as to that, but that is my present impression. That is what the law permits.

Mr. Babcock: In view of your Honor's statement about patent 2,209,944 I would like to reserve the right to argue it.

The Court: All right.

Mr. Babcock: Not right now, though.

The Court: I have absolute confidence that the plaintiff cannot prove invention on 2,209,944. Have you?

Mr. Babcock: Yes, sir.

The Court: I don't think I am going to have any better understanding of this case than I have right now. In fact, I think if I let it go, as I indicated this noon, I will probably be more at sea than I have been, and with all the skill you gentlemen have you probably have observed the difficulty in keeping me on the track; so I think I am prepared to announce my decision at this time.

On the issues involved, as I see them now, it is a question, regarding 2,156,519 first, as to whether or not the plaintiff's [570] Walker's, claims in suit

are invention and valid, and in that respect I hold they are.

The next question as to 2,156,519 is whether or not the use by the defendant of the filter apparatus in the manner which has been described, and which it has admitted using, is [571] infringement; and as to that I hold it is infringement. That disposes of all of the issues involved in patent 2,156,519, isn't that correct?

Mr. Mattingly: Yes.

The Court: As to 2,209,944, I hold against the defendant's contention advanced to the effect that the patent is void, and not being a proper continuation. I hold in favor of the defendant, and against the plaintiffs' claim, that all of the plaintiffs' claims in that suit are invention, and I hold that they are not patentable, and that the patent is not valid. Consequently the patent, not being valid, the defendant could not have infringed. That disposes of 2,209,944.

As to Reissue 21,383, all of the claims involved in patent Reissue 21,383 can be disposed of under the determination of the two issues, as to whether or not the patent is invention, and as to whether or not it has been infringed. I mean, I do not need to go through claims 1 to 11, for the purpose of this ruling, is that correct, counsel?

Mr. Babcock: I think so.

The Court: All of the claims can be disposed of by a determination of whether or not Reissue 21,383 is invention, and as to whether or not it is

infringed; so I don't need to decide claims 1, 2, 3, 4, and down the line. As I remember the patent, and follow the arguments, we have not analyzed [572] this patent claim for claim, as we did 2,209,944. Is there any reason why I have not stated that correctly?

Mr. Mattingly: I think you may dispose of all the claims of that patent.

The Court: By disposition of those two issues?

Mr. Mattingly: That's right.

The Court: In other words, is there any distinction between those claims?

Mr. Babcock: I don't think so.

The Court. As to Reissue 21,383, therefore, I hold that it covers invention, and that the plaintiffs' patent is valid, and that the things done by the defendant in connection with the ascertainment of bottom hole pressure and the ascertainment of potential production of oil wells are infringement. Now, in that regard I want to modify that, because during the argument it was conceded if they have followed certain methods, it would not infringe.

Mr. Mattingly: That's right.

The Court: I will hold that the defendant infringes by the use of any method which involves the taking of two fluid levels higher in the well than the bottom of the pump. I think that covers it, doesn't it?

Mr. Mattingly: Yes, your Honor.

The Court: And the plaintiff is entitled to an injunction, in accordance with the announced judgment I have just [573] made. The findings of fact

and conclusions of law, and judgment will be prepared and submitted by the parties.

[Endorsed]: Filed June 1, 1943. [574]

District Court of the United States, Southern District of California, Central Division

No. 1655-PH

CRANFORD P. WALKER; and CRANFORD P. WALKER, D. A. WALKER, ROBERT P. MILLER and MILO C. KETCHUM, doing business as DEPTHOGRAPH COMPANY,

Plaintiffs and Cross-Appellants

v.

HALLIBURTON OIL WELL CEMENTING COMPANY,

Defendant and Cross-Appellee

STIPULATION AND ORDER FOR TRANSMISSION OF EXHIBITS TO NINTH CIRCUIT COURT OF APPEALS

It Is Stipulated and Agreed by and between counsel for the respective parties hereto that each and every of the following original exhibits on file in the District Court in the above entitled cause be transmitted to the Ninth Circuit Court of Appeals and that the Clerk of the District Court be authorized so to do:

Plaintiffs' Exhibits 1, 2, 3, 6, 7, 8-A, 8-B, 8-C, 8-D

9, 10, 11, 12, 10-A, 10-B, 10-C, 11-A, 11-B, 11-C, 12-A, 12-B, 12-C, 12-D, 12-E, 13, 14, [676] 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29;

Defendant's Exhibits A, B, C, D, E, F, F-1, G, H, I, J, K-1, K-2, K-3, K-4, K-5, K-8, K-9, L, O-2, O-4, O-5, O-7, O-9, O-13, O-14, Q, R, S, T, U.

HAROLD W. MATTINGLY
ROBERT W. FULWIDER
Attorneys for Plaintiffs and Cross-Appellants
FRANK L. A. GRAHAM
EARL BABCOCK
Attorneys for Defendant and Cross-Appellee

Approved and So Ordered:
PEIRSON M. HALL
United States District Judge

July 7, 1943

[Endorsed]: Filed July 7, 1943. [677]

[Title of District Court and Cause.]

STIPULATION AND ORDER RE INSERTION OF EXCERPTS IN THE RECORD ON APPEAL FILED BY DEFENDANT HEREIN

It Is Stipulated and Agreed by and between the parties to the above entitled cause, by their respective counsel, the Court consenting thereto, that the pages of Statement of Points to be relied upon by Plaintiffs in their appeal, Designation of additional portions of the record by Plaintiffs and Defendant,

Defendants amended Answer and the Reporters Transcript of [678] Testimony and proceedings before the District Court filed with Defendants Designation of Portions of the Record to be added to the portions of the record designated by Plaintiffs may be inserted in the Record on Appeal heretofore filed by Defendant-Appellant, and the Clerk of the District Court is hereby authorized to make such insertions.

HAROLD W. MATTINGLY
ROBERT W. FULWIDER
Attorneys for Plaintiffs and Cross-Appellants
FRANK L. A. GRAHAM
EARL BABCOCK
Attorneys for Defendant and Cross-Appellee

It Is So Ordered:

PEIRSON M. HALL
Judge

July 7th, 1943

[Endorsed]: Filed July 7, 1943. [679]

[Title of District Court and Cause.]

DESIGNATION OF CONTENTS OF RECORD ON APPEAL

Comes Now the Halliburton Oil Well Cementing Company, Defendant-Appellant in the above entitled cause, and designates the following portions of the record, proceedings and evidence to be contained in the record on appeal:

Complaint
Bill of Particulars
Answer (abridged)
Findings of Fact and Conclusions of Law
Decree
Notice of Appeal
Designation of Contents of Record on Appeal
Statement of Points on which Defendant-Appellant Intends to Rely on Appeal [680]
Narrative Statement* of Testimony
The following exhibits:

Plaintiffs' Exhibits

1 Walker patent 2,156,519 in suit
2 Walker patent Reissue 21,383 in suit
6 Echo-Meter folder describing Defendant's Apparatus
7 Echo-Meter advertisement
8-A, 8-B, 8-C, 8-D Echo-Meter Field Data Surf Associates Well—State #1
9 Echo-Meter Field Data on Surf Associates Well—State #1
10, 11, 12 Plaintiffs' Interrogatories and Defendant's Answers thereto (combined and abridged)
10-A Drawing—Plaintiffs' illustration of Defendant's apparatus
10-B Graphs made by Defendant's Echo-Meter on Cities Service Well—Ray B-2

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*Footnote: In the Narrative Statement, the page numbers of the official reporter's transcript, from which the narration is taken, appear in the side margin.

10-C Graphs made by defendant's Echo-Meter on Phillips Petroleum Co. Well, Kraft #3

11-A Graph made by Defendant's Echo-Meter on Union Oil Co. Well—Stinson #1

11-B Graph made by Defendant's Echo-Meter on Pace Pet. Corp. Well—McMasters B-1

11-C Echo-Meter Field Manual (abridged)

12-A Drawing of Echo-Meter Casinghead Unit [681]

12-B Photograph of Echo-Meter Casinghead Unit

12-C Photograph of parts of Echo-Meter Casinghead Unit

12-D Photograph of Echo-Meter Electrical Recording Instrument

12-E Calibration curve used to calibrate Filter in Defendant's Echo-Meter Recorder

14 Drawing—Plaintiffs' Illustration of Defendant's Apparatus (the drawing of Exhibit 10-A slightly modified)

18 Prior art patent to Lehr and Wyatt, 2,047,974

19 Graph made by Walker at Shell Oil Co. Well Cosbloom No. 1, Nov. 19, 1935, in attempt to operate apparatus like that of Lehr and Wyatt patent

20 Graph made by Walker on Nov. 20, 1935 in attempt to operate apparatus like that of Lehr and Wyatt patent

21 Graph made by Walker at Shell Oil Co. Well —Cosbloom #1 Dec. 12, 1935, with Depthograph apparatus having no acoustically tuned resonator therein

22 Copy of Drawing made by Walker on blackboard in Court at the trial to illustrate typical conditions in well and pressure and rarefaction waves

23 Commercial Graph made by Walker at Well —Alamitos No. 39, Mar. 6, 1936, with Depthograph having no acoustically [682] tuned resonator therein and with no tubing in the well

24 Graph made by Walker at Well—Nesa #1, Mar. 7, 1936 with Depthograph apparatus having no acoustically tuned resonator therein and with no tubing in the well

25 Charts made with Depthograph on Well #109 showing effects of use of acoustically tuned resonator when tuned to tubing collars and when tuned to casing joints

26 Chart made with Depthograph on Well at El Segundo Apr. 24, 1937 showing effects of use of acoustically tuned resonator

27 Photograph of Depthograph apparatus

28 Photograph of Depthograph apparatus and man operating same

29 Copy of Drawing made by Walker on blackboard in Court at the trial to illustrate effects of tubing collars, casing joints and perforations in pipe on charts made with directional and non-directional microphones

Defendant's Exhibits

C Graph made by Echo-Meter at the trial in demonstrating apparatus to the Court in recording echoes in rubber hose

D Graphs made by Echo-Meter in demonstrating apparatus to Plaintiff before trial at [683] Union

Oil Co. Well Callender #79 and showing graphs made without filter, with filter adjusted properly and with filter maladjusted

E Hot wire microphone—physical exhibit

F Graph made at Duncan, Okla. by apparatus constructed by Defendant in accordance with patent to Lehr and Wyatt No. 2,047,974 using a hot wire microphone

F-1 Same as Exhibit F with marks placed thereon by Dr. Mackeown at the trial

G Graph made at Duncan, Okla. by apparatus constructed by Defendant in accordance with Lehr and Wyatt patent 2,047,974 using a carbon microphone

H Photograph showing Lehr and Wyatt apparatus built by Defendant attached to the well at Duncan, Okla. on which tests were made

I Photograph showing Wyatt and Lehr apparatus using carbon microphone attached to the well at Duncan, Okla.

J Photograph of Defendant's commercial apparatus, the Echo-Meter

K-1 Prior Publication—Wilde and Moore—1931

K-2 Prior Publication—Gill—1932

K-3 Prior Publication—Hawthorn—1933

K-4 Prior Publication—Tucker—1923

K-5 Prior Publication—Ihrig—1935

K-8 (page 194 only) Prior Publication—Millikan—1930 [684]

K-9 Prior Publication—Vietti—1931

L File Wrapper and Contents of Walker ap-

plication, Serial No. 164,534 filed September 18, 1937, disclosing electrical recording system

O-2 Prior Patent—Batcheller 602,422, April 19, 1898

O-4 Prior Patent—Fessenden 1,240,328, September 18, 1917

O-5 Prior Patent—Tucker 1,351,356, August 21, 1920

O-7 Prior Patent—Williams 1,671,262, May 29, 1928

O-9 Prior Patent—Taylor 1,847,636, March 1, 1932

O-13 Prior Patent—Scott 2,173,426, August 30, 1937

O-14 Prior Patent—Halliburton 2,201,311, May 21, 1940

Q File Wrapper and contents of Walker application Serial No. 171,170 filed October 26, 1937 on Method of Determining Fluid Density, etc.

R File Wrapper and contents of Walker Patent 2,161,733 granted June 6, 1939 on Method of Determining Fluid Density, etc. (The application which resulted in this patent was a "continuation" of Exhibit Q)

S File Wrapper and contents of Walker Reissue Patent 21,383 (in suit), granted March 5, 1940, on Method of [685] Determining Fluid Density, etc. (This patent is a reissue of Exhibit R)

T File Wrapper and contents of Walker Patent 2,156,519 (in suit) granted May 2, 1939 for Means for Measuring the Location of Obstructions in Wells

U File Wrapper and contents of Wyatt and

Lehr patent 2,047,974 granted July 21, 1936 for Method and Apparatus for Measuring Well Depths.

Two copies of the designated proceedings, testimony, and abridged exhibits 10, 11, 12 and 11-C are filed herewith.

FRANK L. A. GRAHAM
EARL BABCOCK
Attorneys for Defendant-Appellee

Service of a copy of this designation, together with a copy of the designated proceedings, testimony and abridged Exhibits 10, 11, 11-C and 12, is hereby acknowledged.

HAROLD W. MATTINGLY
Attorney for Plaintiffs-Appellees

June 1, 1943

[Endorsed]: Filed June 1, 1943. [686]

[Title of District Court and Cause.]

DESIGNATION OF CONTENTS OF RECORD ON APPEAL OF PLAINTIFFS TO BE ADDED TO THE DESIGNATION BY DEFENDANT ON ITS APPEAL

To the Clerk of the above entitled Court:

You are hereby requested for plaintiffs' appeal to add to the transcript of the record designated by defendant in its appeal hereinafter mentioned items to make a single record in the appeals of plaintiffs

and defendant, said record to be filed in the United States Circuit Court of Appeals for the Ninth Circuit pursuant to such appeals. [687]

The additional items are as follows:

(1) Statement of Points on which plaintiffs and cross-appellants intend to rely on appeal.

(2) The Amended Answer of defendant filed on or about April 13, 1942.

(3) Plaintiffs' Notice of Appeal filed May 17, 1943.

(4) Plaintiffs' Exhibit 3—Walker patent No. 2,209,944.

(5) Plaintiffs' Exhibit 13—Stipulation as to Certain Facts.

(6) This designation.

(7) Excerpts from the Reporter's Transcript of Testimony and Proceedings on Trial and Reporter's Transcript of Arguments.

Two copies of the designated excerpts from the Reporter's Transcript of Testimony and Proceedings on Trial and Arguments, and Exhibit 13 are filed herewith.

HAROLD W. MATTINGLY
ROBERT W. FULWIDER
Attorneys for Plaintiffs and Cross-Appellants

Service of a copy of this Designation, together with a copy of the designated excerpts is hereby acknowledged.

FRANK L. A. GRAHAM
EARL BABCOCK
Attorneys for Defendant and Cross-Appellee

[Endorsed]: Filed June 25, 1943. [688]

[Title of District Court and Cause.]

STIPULATION AND ORDER EXTENDING DEFENDANT-CROSS APPELLEE'S TIME FOR FILING DESIGNATION OF ADDITIONAL MATTER TO BE INCLUDED IN THE APPEAL TAKEN BY PLAINTIFFS-CROSS APPELLANTS

It Is Stipulated and Agreed by and between the parties in the above-entitled cause, by their respective counsel, the Court consenting thereto, that the time within which the defendant and cross-appellee may file designation of additional matter to be included in the appeal taken by the plaintiffs and

cross-appellants shall be extended to and including July 7, 1943. [689]

HAROLD W. MATTINGLY
ROBERT W. FULWIDER
Attorneys for Plaintiffs and Cross-Appellants
FRANK L. A. GRAHAM
EARL BABCOCK
Attorneys for Defendant and Cross-Appellee

It Is So Ordered:

PEIRSON M. HALL
Judge

July 2, 1943

[Endorsed]: Filed July 2, 1943. [690]

[Title of District Court and Cause.]

DESIGNATION BY DEFENDANT OF PORTIONS OF THE RECORD TO BE ADDED TO PORTIONS DESIGNATED BY PLAINTIFFS

The Plaintiffs herein for their appeal on Patent No. 2,209,944 having designated certain portions of the record to be added to Defendant's designation on its appeal on Patents No. 2,156,519 and Re 21,383;

Now comes the Defendant, Halliburton Oil Well Cementing Company, and designates the following portions of the record, proceedings and evidence to

be contained in the record on Plaintiffs' appeal on Patent No. 2,209,944 in addition to the portions designated by Plaintiffs.

The additional items are as follows:

(1) Defendant's Exhibit A—Certified copy of [691] File Wrapper and Contents of Abandoned Application for Patent of Cranford P. Walker, Serial No. 270,865, filed Apr. 29, 1939.

(2) Defendant's Exhibit B—Certified Copy of File Wrapper and Contents of Application which Resulted in Patent 2,209,944 in suit, which Application was filed Sept. 25, 1939.

(3) Excerpts from the Reporter's Transcript of Testimony and Proceedings before the District Court. Two copies of these excerpts are filed herewith. For convenience and clarity, these excerpts have been combined with those designated by Plaintiffs and typed for substitution and insertion in the Narrative Statement of Testimony and Proceedings heretofore filed by Defendant.

(4) This Designation.

(5) Order of the District Court Extending Time to File Record and Docket Appeal.

(6) Stipulation Regarding Printing of Exhibits.

(7) Stipulation and order extending time to file this Designation.

FRANK L. A. GRAHAM
EARL BABCOCK
Attorneys for Defendant

Service of a copy of this designation, together with a copy of the designated proceedings and testimony is hereby acknowledged.

HAROLD W. MATTINGLY
ROBERT W. FULWIDER
Attorneys for Plaintiffs

[Endorsed]: Filed July 7, 1943. [692]

[Title of District Court and Cause.]

ORDER EXTENDING TIME TO FILE RECORD AND DOCKET APPEAL

On motion of Frank L. A. Graham and Earl Babcock, attorneys for Defendant-Appellant, and good cause appearing therefor;

It Is Hereby Ordered:

That the time within which the Record on Appeal, as provided in Rules 73, 75 and 76 of the Rules of Civil Procedure, shall be filed with the Circuit Court of Appeals and the appeal there docketed is hereby extended up to and including July 21, 1943.

Dated at Los Angeles, California, June 17 1943

PEIRSON M. HALL
Judge

[Endorsed]: Filed June 17, 1943. [693]

[Title of District Court and Cause.]

ORDERING ENLARGING TIME FOR FILING RECORD AND DOCKETING APPEAL

On motion of the plaintiffs herein, good cause appearing therefor, the time for filing of the record on appeal and for docketing the appeal in the Circuit Court of Appeals in the above entitled cause is hereby enlarged to and including the 21st day of July, 1943.

Dated at Los Angeles, California, this 23rd day of June, 1943.

PAUL J. McCORMICK
United States District Judge

[Endorsed]: Filed June 23, 1943. [694]

[Title of District Court and Cause.]

STIPULATION AND ORDER ENLARGING TIME FOR FILING RECORD AND DOCKETING APPEAL

It Is Stipulated and Agreed by and between counsel for the respective parties hereto that the time for filing of the record on appeal and for docketing the appeals in the Circuit Court of Ap-

peals in the above entitled cause shall be enlarged to and including the 10th day of August, 1943.

HAROLD W. MATTINGLY
ROBERT W. FULWIDER
Attorneys for Plaintiffs
FRANK L. A. GRAHAM
EARL BABCOCK
Attorneys for Defendant

7/14/43

So Ordered:

PEIRSON M. HALL
Judge

[Endorsed]: Filed July 14, 1943. [695]

[Title of District Court and Cause.]

CERTIFICATE OF CLERK

I, Edmund L. Smith, Clerk of the District Court of the United States for the Southern District of California, do hereby certify that the foregoing pages numbered from 1 to 695 inclusive contain full, true and correct copies of: Bill of Complaint; Bill of Particulars (except exhibits); Amended Answer of Defendant; Findings of Fact and Conclusions of Law; Decree; Notice of Appeal; Cost Bond on Appeal; Statement of Points on which Defendant-Appellant Intends to Rely on Appeal; Notice of Appeal to the Circuit Court of Appeals; Bond on Appeal; Statement of Points on which Plaintiffs and Cross-Appellants Intend to Rely on Appeal; Narrative Statement of Testimony and

Proceedings in District Court; Stipulation and Order for Transmission of Exhibits to Ninth Circuit Court of Appeals; Stipulation and Order re Insertion of Excerpts in the Record on Appeal filed by Defendant Herein; Designation of Contents of Record on Appeal; Designation of Contents of Record on Appeal of Plaintiffs to be Added to the Designation by Defendant on its Appeal; Stipulation and Order Extending Defendant-Cross Appellee's Time for filing Designation of Additional Matter to be Included in the Appeal Taken by Plaintiffs-Cross Appellants; Designation by Defendant of Portions of the Record to be added to Portions Designated by Plaintiffs; Order Extending Time to File Record and Docket Appeal; Order Enlarging Time for Filing Record and Docketing Appeal and Stipulation and Order Enlarging Time for Filing Record and Docketing Appeals which, together with Original Exhibits transmitted herewith, constitute the record on appeal to the Circuit Court of Appeals for the Ninth Circuit.

I further certify that my fees for comparing, correcting and certifying the foregoing record amount to $93.45 of which amount $84.90 has been paid to me by defendant-appellant and $8.55 has been paid to me by plaintiffs-cross appellants.

Witness my hand and the seal of said District Court this 29 day of July, 1943.

(Seal) EDMUND L. SMITH,
Clerk
By THEODORE HOCKE
Deputy Clerk.

[Endorsed]: No. 10513. United States Circuit Court of Appeals for the Ninth Circuit. Halliburton Oil Well Cementing Company, a Delaware Corporation, Appellant, vs. Cranford P. Walker, and Cranford P. Walker, D. A. Walker, Robert P. Miller and Milo C. Ketchum, doing business as Depthograph Company, a copartnership, Appellees. Cranford P. Walker, and Cranford P. Walker, D. A. Walker, Robert P. Miller and Milo C. Ketchum, doing business as Depthograph Company, a copartnership, Appellants, vs. Halliburton Oil Well Cementing Company, a Delaware corporation, Appellee. Transcript of Record. Upon Appeals from the District Court of the United States for the Southern District of California, Central Division.

Filed August 2, 1943.

PAUL P. O'BRIEN,

Clerk of the United States Circuit Court of Appeals for the Ninth Circuit.

In the United States Circuit Court of Appeals for the Ninth Circuit

CIVIL

No. 10513

HALLIBURTON OIL WELL CEMENTING COMPANY, a Delaware Corporation,

Defendant-Appellant,

v.

CRANFORD P. WALKER; and CRANFORD P. WALKER, D. A. WALKER, ROBERT P. MILLER and MILO C. KETCHUM, doing business as DEPTHOGRAPH COMPANY, a co-partnership,

Plaintiffs-Appellees.

STATEMENT OF POINTS ON WHICH DEFENDANT-APPELLANT INTENDS TO RELY ON APPEAL

Comes now the Defendant-Appellant in the above entitled cause and, in accordance with Rule 19 (6) of the United States Circuit Court of Appeals for the Ninth Circuit, states that on the appeal the following points will be relied on:

1. The District Court erred in adjudging United States Letters Patent 2,156,519 good and valid in law and particularly as to claims 1, 13, 14, 15 and 17 thereof.

2. The District Court erred in adjudging that the defendant Halliburton Oil Well Cementing

Company has infringed United States Letters Patent 2,156,519, and particularly claims 1, 13, 14, 15 and 17 thereof.

3. The District Court erred in finding that the claims of United States Letters Patent 2,156,519 define invention over the prior art.

4. The District Court erred in according United States Letters Patent 2,156,519 a broad range of equivalents, particularly after having found it to be merely an "improvement" patent.

5. The District Court erred in finding that an electrical filter circuit as part of an electrical sound recording system is the equivalent of a mechanical acoustically tuned resonator (a pipe of a particular length) as part of a mechanical recording system.

6. The District Court erred in not finding that the proceedings in the Patent Office estop Plaintiffs from asserting that an electrical filter circuit is the equivalent of an acoustically tuned resonator in the apparatus of United States Letters Patent 2,156,519.

7. The District Court erred in not finding that mechanical acoustically tuned resonators were old and well known in the art prior to United States Letters Patent 2,156,519 and that no invention was involved in using an acoustically tuned resonator in known mechanical sound recording systems, particularly those of the claims of United States Letters Patent 2,156,519 in suit.

8. Having found that it was old in the art prior to United States Letters Patent 2,156,519 to fire a

gun into a pipe and mechanically record the echo from an obstruction in the pipe, and having found that it was also old in the art to inject into a well casing a charge of gas from a cylinder of gas under pressure and record electrically the echoes from obstructions in the well, the District Court erred in finding that the apparatus of United States Letters Patent 2,156,519 differs from and is an improvement over the prior art and particularly in finding that invention is involved in the incorporation into such old apparatus of tuned acoustical means (a pipe of a particular length.)

9. The District Court erred in adjudging United States Reissue Letters Patent 21,383 good and valid in law as to each of the claims thereof.

10. The District Court erred in adjudging that defendant Halliburton Oil Well Cementing Company has infringed all or any of the claims of United States Letters Patent Reissue 21,383, and particularly that defendant Halliburton Oil Well Cementing Company should be enjoined from "using, practicing or selling or causing to be used, practiced or sold any method for determining pressure in the fluid column of a well, or determining density of the fluid in the fluid column in a well, or determining the production capacity, productivity index or potential of a well which includes the steps of taking two gas pressure measurements and two corresponding fluid level measurements and comparing them."

11. The District Court erred in finding that the

claims of United States Letters Patent Reissue 21,383 define invention over the prior art.

12. The District Court erred in not finding that claims 1 to 8, inclusive, of United States Letters Patent Reissue 21,383 are limited to the determination of density of fluid and that any process which does not include the determination of density is not an infringement of said claims 1 to 8, inclusive.

13. The District Court erred in not finding that during the prosecution of the application for United States Letters Patent 2,161,733, (the original of Reissue 21,383) all the claims were intentionally and expressly limited to the determination of density and that claims not limited to the determination of density were cancelled and abandoned and that therefore claims 9, 10 and 11 of Reissue 21,383 must be interpreted as also limited to the determination of density to save them from a holding of invalidity.

14. The District Court erred in not finding that the only novelty in United States Letters Patent Reissue 21,383 resides in the mental of mathematical steps of "dividing", "comparing", "determining," etc. which do not constitute patentable subject matter.

15. The District Court erred in not finding that Plaintiffs, by this action are attempting to assert a broad and dominating monopoly wholly unsupported by any alleged invention made by Cranford P. Walker, Plaintiff, and wholly unsupported by any alleged invention disclosed in United States

Letters Patent 2,156,519 and Reissue 21,383, and in not finding that the commercial success enjoyed by Plaintiffs in their Depthograph business is due primarily to the inventions of the prior art and Plaintiffs' exploitation thereof, rather than to the alleged inventions of Patents 2,156,519 and Reissue 21,383 in suit.

FRANK L. A. GRAHAM
EARL BABCOCK,
Attorneys for Defendant-Appellant

Service of a copy of this Statement of Points on Which Defendant-Appellant Intends to Rely on Appeal is hereby acknowledged.

HAROLD W. MATTINGLY
ROBERT W. FULWIDER
Attorneys for Plaintiffs-Appellees

[Endorsed]: Filed Aug. 2, 1943. Paul P. O'Brien, Clerk.

In the United States Circuit Court of Appeals for the Ninth Circuit

Appeal No. 10513

HALLIBURTON OIL WELL CEMENTING COMPANY, a Delaware corporation,

Defendant-Appellant

v.

CRANFORD P. WALKER; and CRANFORD P. WALKER, D. A. WALKER, ROBERT P. MILLER and MILO C. KETCHUM, doing business as DEPTHOGRAPH COMPANY, a co-partnership,

Plaintiffs-Appellee.

CRANFORD P. WALKER; and CRANFORD P. WALKER, D. A. WALKER, ROBERT P. MILLER and MILO C. KETCHUM, doing business as DEPTHOGRAPH COMPANY, a co-partnership,

Plaintiffs-Appellants

v.

HALLIBURTON OIL WELL CEMENTING COMPANY, a Delaware corporation,

Defendant-Appellee

DESIGNATION OF HALLIBURTON OIL WELL CEMENTING COMPANY AS DE-

FENDANT-APPELLANT IN THE FIRST APPEAL AND AS DEFENDANT-APPELLEE IN THE SECOND APPEAL.

To the Clerk of the above-entitled Court:

Halliburton Oil Well Cementing Company as Defendant-Appellant in the first appeal and as Defendant-Appellee in the second appeal, hereby designates the parts of the record which it deems necessary for consideration on both appeals herein; said parts to be printed from the record, proceedings and evidence contained in the certified record transmitted by the Clerk of the United States District Court for the Southern District of California to this Court.

You are hereby requested to include and reproduce in a printed record in the above-entitled appeals the following:

(1) The entire Certified Transcript of Record, certified to the Circuit Court of Appeals by the Clerk of the District Court.

(2) Stipulation and Order regarding the printing of Exhibits, (filed herewith).

(3) This Designation.

(4) Statement of points on which Defendant-Appellant intends to rely on appeal, (filed herewith).

(5) The following Exhibits:

Plaintiffs' Exhibits

1 Walker patent 2,156,519 in suit.
2 Walker patent Reissue 21,383 in suit.
3 Walker patent 2,209,944 in suit.

6. Echo-Meter folder describing Defendant's Apparatus.

7 Echo-Meter advertisement.

8-A, 8-B, 8-C, 8-D Echo-Meter Field Data, Surf Associates Well - State #1.

9 Echo-Meter Field Data on Surf Associates Well - State #1.

10, 11, 12 Plaintiffs' Interrogatories and Defendant's Answers thereto (combined and abridged).

10-A Drawing - Plaintiffs' illustration of Defendant's apparatus.

10-B Graphs made by Defendant's Echo-Meter on Cities Service Well - Ray B-2.

10-C Graphs made by Defendant's Echo-Meter on Phillips Petroleum Co. Well, Kraft #3.

11-A Graph made by Defendant's Echo-Meter on Union Oil Co. Well—Stinson #1.

11-B Graph made by Defendant's Echo-Meter on Pace Pet. Corp. Well—McMasters B-1.

11-C Echo-Meter Field Manual (abridged).

12-A Drawing of Echo-Meter Casinghead Unit.

12-B Photograph of Echo-Meter Casinghead Unit.

12-C Photograph of parts of Echo-Meter Casinghead Unit.

12-D Photograph of Echo-Meter Electrical Recording Instrument.

12-E Calibration curve used to calibrate Filter in Defendant's Echo-Meter Recorder.

13 Stipulation as to Certain Facts.

14 Drawing—Plaintiffs' Illustration of Defend-

ant's Apparatus (the drawing of Exhibit 10-A slightly modified).

18 Prior art patent to Lehr and Wyatt, 2,047,-974.

19 Graph made by Walker at Shell Oil Co. Well Cosbloom No. 1, Nov. 19, 1935, in attempt to operate apparatus like that of Lehr and Wyatt patent.

20 Graph made by Walker on Nov. 20, 1935 in attempt to operate apparatus like that of Lehr and Wyatt patent.

21 Graph made by Walker at Shell Oil Co. Well —Cosbloom #1, Dec. 12, 1935, with Depthograph apparatus having no acoustically tuned resonator therein.

22 Copy of Drawing made by Walker on blackboard in Court at the trial to illustrate typical conditions in well and pressure and rarefaction waves.

23 Commercial graph made by Walker at Well —Alamitos No. 39, Mar. 6, 1936, with Depthograph having no acoustically tuned resonator therein and with no tubing in the well.

24 Graph made by Walker at Well—Nesa #1, Mar. 7, 1936 with Depthograph apparatus having no acoustically tuned resonator therein and with no tubing in the well.

25 Charts made with Depthograph on Well #109 showing effects of use of acoustically tuned resonator when tuned to tubing collars and when tuned to casing joints.

26 Chart made with Depthograph on Well at El Segundo Apr. 24, 1937 showing effects of use of acoustically tuned resonator.

27 Photograph of Depthograph apparatus.

28. Photograph of Depthograph apparatus and man operating same.

29 Copy of Drawing made by Walker on blackboard in Court at the trial to illustrate effects of tubing collars, casing joints and perforations in pipe on charts made with directional and non-directional microphones.

Defendant's Exhibits

A Certified copy of File Wrapper and Contents of Abandoned Application for Patent of Cranford P. Walker, Serial No. 270,865, filed Apr. 29, 1939.

B Certified Copy of File Wrapper and Contents of Application which Resulted in Patent 2,209,944 in suit, which Application was filed Sept. 25, 1939.

C Graph made by Echo-Meter at the trial in demonstrating apparatus to the Court in recording echoes in rubber hose.

D Graphs made by Echo-Meter in demonstrating apparatus to Plaintiff before trial at Union Oil Co. Well Callender #79 and showgraphs made without filter, with filter adjusted properly and with filter maladjusted.

E Hot wire microphones—physical exhibit.

F Graph made at Duncan, Okla. by apparatus constructed by Defendant in accordamce with patent to Lehr and Wyatt No. 2,047,974 using a hot wire microphone.

F-1 Same as Exhibit F with marks placed thereon by Dr. Mackeown at the trial.

G Graph made at Duncan, Okla. by apparatus constructed by Defendant in accordance with Lehr

and Wyatt patent 2,047,974 using a carbon microphone.

H Photograph showing Lehr and Wyatt apparatus built by Defendant attached to the well at Duncan, Okla. on which tests were made.

I Photograph showing Wyatt and Lehr apparatus using carbon microphone attached to the well at Duncan, Okla.

J Photograph of Defendant's commercial apparatus, the Echo-Meter.

K-1 Prior Publication—Wilde and Moore—1931.

K-2 Prior Publication—Gill—1932.

K-3 Prior Publication—Hawthorn—1933.

K-4 Prior Publication—Tucker—1923.

K-5 Prior Publication—Ihrig—1935.

K-8 (page 194 only).
Prior Publication—Milliken—1930.

K-9 Prior Publication—Vietti—1931.

L File Wrapper and Contents of Walker application, Serial No. 164,534 filed September 18, 1937, disclosing electrical recording system.

O-2 Prior Patent—Batcheller 602,422, Apr. 19, 1898.

O-4 Prior Patent—Fessenden 1,240,328, Sept. 18, 1917.

O-5 Prior Patent—Tucker 1,351,356, Aug. 21, 1920.

O-7 Prior Patent—Williams 1,671,262, May, 29, 1928.

O-9 Prior Patent—Taylor 1,847,636, Mar. 1, 1932.

O-13 Prior Patent—Scott 2,173,426, Aug. 30, 1937.

O-14 Prior Patent—Halliburton 2,201,311, May 21, 1940.

Q File Wrapper and contents of Walker application Serial No. 171,170 filed October 26, 1937 on Method of Determining Fluid Density, etc.

R File Wrapper and contents of Walker Patent 2,161,733 granted June 6, 1939 on Method of Determining Fluid Density, etc. (The application which resulted in this patent was a "continuation" of Exhibit Q).

S File Wrapper and contents of Walker Reissue Patent 21,383 (in suit), granted Mar. 5, 1940, on Method of Determining Fluid Density, etc. (This patent is a reissue of Exhibit R).

T File Wrapper and contents of Walker Patent 2,156,519 (in suit) granted May 2, 1939 for Means for Measuring the Location of Obstructions in Wells.

U File Wrapper and contents of Wyatt and Lehr patent 2,047,974 granted July 21, 1936 for Method and Apparatus for Measuring Well Depths.

For use in printing the record, the attention of the Clerk is called to the fact that the "Record on Appeal" filed herewith, contains abridged forms of Exhibits 10, 11, 12 and 11-C. It is asked that these be printed rather than original Exhibits 10, 11, 12 and 11-C. It is asked that all the other exhibits designated, except physical Exhibit E, be

printed from the original exhibits sent to the Court of Appeals herewith.

FRANK L. A. GRAHAM
EARL BABCOCK
Attorneys for Defendant-Appellant
Attorneys for Defendant-Appellee

Service of copy of this designation is hereby acknowledged this 22nd day of July, 1943.

HAROLD W. MATTINGLY
Attorneys for Plaintiffs-Appellee
ROBERT W. FULWIDER
Attorneys for Plaintiffs-Appellant

[Endorsed]: Filed Aug. 2, 1943. Paul P. O'Brien, Clerk.

In the United States Circuit Court of Appeals for the Ninth Circuit

No. 10513

HALLIBURTON OIL WELL CEMENTING COMPANY,

Appellant,

v.

CRANFORD P. WALKER; and CRANFORD P. WALKER, D. A. WALKER, ROBERT P. MILLER and MILO C. KETCHUM, doing business as DEPTHOGRAPH COMPANY, a co-partnership,

Appellees.

STIPULATION REGARDING PRINTING OF EXHIBITS

It is hereby stipulated by and between counsel for the respective parties, the Circuit Court of Appeals for the Ninth Circuit consenting thereto, that only ten (10) copies of the books of exhibits be printed, six copies for the use of the Court and four copies for the use of counsel, two to each party.

It is further stipulated that the following exhibits be included in the printed books of exhibits and that, except for Defendant's physical Exhibit "E", the books of exhibits shall constitute all the exhibits before the Circuit Court of Appeals for the Ninth Circuit on this appeal:

Plaintiffs' Exhibits 1, 2, 3, 6, 7, 8-A, 8-B, 8-C.

8-D, 9; a combined and abridged draft of Exhibits 10, 11 and 12; 10-A, 10-B, 10-C, 11-A, 11-B; an abridged draft of Exhibit 11-C; 12-A, 12-B, 12-C, 12-D, 12-E, 13, 14, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29;

Defendant's Exhibits A, B, C, D, F, F-1, G, H, I, J, K-1, K-2, K-3, K-4, K-5; page 194 only of Exhibit K-8; K-9, L, O-2, O-4, O-5, O-7, O-9, O-13, O-14, Q, R, S, T, U.

It is further stipulated that Plaintiffs' Exhibit 18, the prior art patent to Lehr and Wyatt No. 2,047,974, be bound in the book of exhibits following Defendant's Exhibit O-9, instead of Plaintiffs' exhibits, so that all the prior art patents will appear in the record in one place, and the Clerk is requested to have the book of exhibits so bound.

FRANK L. A. GRAHAM
EARL BABCOCK
Attorneys for Defendant-Appellant

HAROLD W. MATTINGLY
ROBERT W. FULWIDER
Attorneys for Plaintiffs-Appellees

So Ordered:

ALBERT LEE STEPHENS
Judge,
United States Circuit Court of Appeals Ninth Circuit

[Endorsed]: Filed Aug. 2, 1943. Paul P. O'Brien, Clerk.

[Title of Circuit Court of Appeals and Cause.]

PLAINTIFFS' DESIGNATION OF THE PARTS OF THE RECORD TO BE INCLUDED IN THE PRINTED RECORD AND BOOK OF EXHIBITS FOR PLAINTIFFS' APPEAL

A. For the printed record:

(All reference to page numbers made herein refers to the page numbers of the Transcript of Record, as certified to this Court).

1. Those parts of the Complaint as follows:

(a) Introduction (Page 3).

(b) Paragraphs numbered I, II, III, IV, VII, VIII, IX, X (Pages 3, 4, 5 and 6).

(c) Prayer (Page 6).

2. Those parts of the Amended Answer as follows:

(a) Introduction (Page 10).

(b) Paragraphs I, II, III, IV, VII, VIII, IX, X, XI, XII, XIII, XIX(a) only, XXII, XXIII, XXIV, XXXIV (Pages 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 24).

(c) Prayer (Page 24).

3. Those parts of the Findings of Fact and Conclusions of Law as follows:

(a) Introduction (Page 25).

(b) Paragraphs of Findings of Fact—1, 2, 3, 4, 5 and 7 (Pages 25 and 26).

(c) Paragraphs of Conclusions of Law—I, II VII (Pages 28 and 29).

4. The Decree (Pages 31, 32, 33).

5. Plaintiffs' Notice of Appeal (Page 41).

6. Those parts of the Narrative Statement of Testimony and Proceedings in District Court as follows:

Page 48, Lines 1 through 22
Page 51, Lines 8 through 12
Page 57, Line 8 through Page 61, Line 7
Page 62, Line 13 through Page 72, Line 19
Page 82, Line 18 through Page 87, Line 9
Page 99, Line 18 to end of page
Page 105, Line 1 through Page 106, Line 8
Page 116, Line 15 through Page 119, Line 14
Page 120, Line 1 to end of page
Page 121, Line 1, through Page 122, Line 17
Page 131, last line only, through Page 135, Line 4
Page 154, Line 1 through Page 193, Line 1
Page 198, Line 10 through Page 203, Line 15
Page 204, Line 13 through Page 207, Line 15
Page 218, Line 7, through Page 220, Line 24
Page 230, Lines 7 through 21
Page 234, Line 18 through Page 243, Line 8
Page 248, Lines 1 through 15
Page 258, Line 17 through Page 261, last line
Page 268, Lines 1 through 10
Page 268, Line 21 though Page 269, Line 11
Page 273, Line 13 through Page 278, Line 14
Page 543, Line 1, through Page 552, Line 8

7. Statement of Points upon which Plaintiffs will rely on their appeal. (Filed in the Circuit Court of Appeals)

8. This designation.

B. For the Book of Exhibits:

1. Plantiffs' Exhibit 3 Walker Patent 2,209,-944 (copies to be furnished by Plaintiffs).
2. Plaintiffs' Exhibit 19
3. Plaintiffs' Exhibit 20
4. Plaintiffs' Exhibit 21
5. Plaintiffs' Exhibit 13.
6. Defendant's Exhibit T.

Dated at Los Angeles, California, this 10th day of August, 1943.

HAROLD W. MATTINGLY
ROBERT W. FULWIDER
Attorneys for Plaintiffs-Appellants

Received service of the within Plaintiffs' Designation of the Parts of the Record, etc. this 10th day of August, 1943.

FRANK L. A. GRAHAM
Attorney for Defendant-Appellee

[Endorsed]: Filed Aug. 14, 1943. Paul P. O'Brien, Clerk.

In the United States Circuit Court of Appeals for the Ninth Circuit

Appeal No. 10513

CRANFORD P. WALKER; and CRANFORD P. WALKER, D. A. WALKER, ROBERT P. MILLER and MILO C. KETCHUM, doing business as DEPTHOGRAPH COMPANY, a co-partnership,

Plaintiffs-Appellants,

v.

HALLIBURTON OIL WELL CEMENTING COMPANY, a Delaware corporation,

Defendant-Appellee.

STATEMENT OF POINTS TO BE RELIED UPON BY PLAINTIFFS-APPELLANTS, CRANFORD P. WALKER, et al.

Plaintiffs-Appellants, Cranford P. Walker, and Cranford P. Walker, D. A. Walker, Robert P. Miller and Milo C. Ketchum, doing business as Depthograph Company, hereby adopt as their statement of points on appeal the document filed in the District Court on June 25, 1943, entitled "State ment of Points on which Plaintiffs and Cross-Appellants Intend to Rely on Appeal", of which the following is a copy:

"1. The District Court erred in adjudging United States Letters Patent 2,209,944 invalid.

2. The District Court erred in adjudging United

States Letters Patent No. 2,209,944 invalid as to each of the claims thereof as defining methods which do not involve invention and are unpatentable.

3. The District Court erred in failing to find that the claims of United States Letters Patent No. 2,209,944 and each of them define patentable invention over the prior art.

4. The District Court erred in failing to find that the claims of United States Letters Patent No. 2,209,944 and each of them define a patentable method comprising a series of physical steps to produce information from which the results described may be computed.

5. The District Court erred in failing to find that the only prior art submitted by the defendant pertaining to the questions of anticipation and lack of invention were the same prior art which had been considered by the United States Patent Office during the prosecution of the applications resulting in United States Letters Patent No. 2,209,944 and that said Letters Patent and each of the claims thereof define patentable invention over any of such prior art.

6. The District Court erred in failing to find that the invention set forth and claimed in United States Letters Patent No. 2,209,944 was a very meritorious invention, constituted a distinct advance in the art to which it relates, solved successfully for the first time a problem on which others had made many attempts but had never succeeded

and that said patent is entitled to a liberal interpretation.

7. The District Court erred in finding that 'United States Letters Patent No. 2,209,944 is a method patent and discloses and claims certain methods of determining the locations of obstructions in a well by introducing into the well a pressure wave and the recording of echoes from the various known obstructions or partial obstructions in the well, and calculating from information so acquired the location of the obstructions. The novelty of this structure consists only in the performance of mental steps such as "counting", "observing", "computing" and "comparing", which do not involve invention.'

8. The District Court erred in failing to find that none of the prior art before the Court disclosed or taught the methods defined in the claims of United States Letters Patent No. 2,209,944.

9. The District Court erred in failing to find that the novelty in the methods defined in the claims of United States Letters Patent No. 2,209,944 is more than the mere performance of mental steps and does involve invention.

10. The District Court erred in failing to find that the defendant has infringed each and every of the claims of United States Letters Patent No. 2,209,944.

11. The District Court erred in not awarding costs of suit to plaintiffs."

Dated at Los Angeles, California, this 10th day of August, 1943.

HAROLD W. MATTINGLY
ROBERT W. FULWIDER
Attorneys for Plaintiffs-Appellants

Received service of the within Statement of Points, etc. this 10th day of August, 1943.

FRANK L. A. GRAHAM
Attorney for Defendant-Appellee

[Endorsed]: Filed Aug. 14, 1943. Paul P. O'Brien, Clerk.